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A Risky Business: Generation of Nuclear Power and Deepwater Drilling for Offshore Oil and Gas

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INTRODUCTION

> "You pull the ripcord on the parachute you packed . . . [n]ot the parachute you wish you had packed."[1]

Government regulation and licensing of industrial activities that create the possibility of catastrophic risk reflect "a political value judgment that these activities provide a social benefit that is greater than the social cost of the risks that they cause."[2] However, when a catastrophic accident occurs, the cost-benefit evaluations underlying the value judgment that authorized the activity may need to be rethought.[3] Social rethinking is especially warranted when the accident could have been prevented had either the industry or the government more seriously assessed the risk of a catastrophic event and implemented precautionary steps to avoid it. This was the conclusion reached by the President's Oil Spill Commission with respect to the *Deepwater Horizon* drilling rig accident in April 2010, which killed eleven platform workers, injured seventeen more, discharged nearly five million barrels of oil into the Gulf of Mexico,[4] devastated the area's economy and

1. Campbell Robertson, *Efforts to Repel Gulf Spill Are Described as Chaotic, Fragmented Response Cited—Contingency Plans Are Found Lacking in Detail*, N.Y. TIMES, June 15, 2010, at A1, *available at* http://www.nytimes.com/2010/06/15/science/earth/15cleanup.html (quoting Mark Davis, director of the Tulane Institute on Water Resources Law and Policy).

2. Marcus Radetzki & Marian Radetzki, *Liability of Nuclear and Other Industrial Corporations for Large Scale Accident Damage*, 15 J. ENERGY & NAT. RESOURCES L. 366, 383 (1997).

3. *Cf.* Jay G. Martin, *Implementing Effective Corporate Legal Compliance Programs*, NAT. RESOURCES & ENV'T, Spring 1997, at 14, 14 ("[D]amage that can be caused by a large company or a group of them acting in concert makes it unacceptable simply to wait and fix things after the fact. Thus, there is a need to channel business activity constructively and to identify and address problems before they become catastrophic.").

4. *See* Nat'l Comm'n on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *The Amount and Fate of the Oil* 16 (Staff Working Paper No. 3, 2011) [hereinafter Staff Working Paper No. 3], *available at* http://www.oilspillcommission.gov/sites/default/files/documents/Updated%20Amount%20and%20Fate%20of%20the%20Oil%20Working%20Paper.pdf ("The emerging consensus among government and independent scientists is that roughly five million barrels of oil were released by the Macondo well, with over four million barrels pouring into the waters of the Gulf of Mexico.").

environment, and to date has cost hundreds of millions of dollars to clean up.[5] Because the *Deepwater Horizon* debacle was not the first serious accident at an offshore drilling rig in recent memory, these failures in oversight are surprising. For reasons this Article will explore, the companies that engage in offshore drilling for oil and gas, and the agencies that regulate them, assess the risk of an operational accident as very low, despite the fact that serious well blowouts are not infrequent events. That assessment affects both the stringency of regulatory oversight and the precautionary steps a company takes to guard against the occurrence of accidents.

Given the recurrence of serious well blowouts during the past forty years, the inattentive attitude of the offshore oil and gas industry and the Department of the Interior toward the likelihood of a serious accident occurring again is even more striking when compared to the reaction of the nuclear power industry following the catastrophic partial nuclear core meltdown at Three Mile Island Unit 2 (TMI-2).[6] It took only one major accident to jolt the Nuclear Regulatory Commission (NRC) and the nuclear industry almost immediately into taking proactive regulatory and operational steps to dissuade the country from rethinking its commitment to commercial nuclear power.[7] From a somewhat

5. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-11-90R, DEEPWATER HORIZON OIL SPILL: PRELIMINARY ASSESSMENT OF FEDERAL FINANCIAL RISKS AND COST REIMBURSEMENT AND NOTIFICATION PROCEDURES, 1–2 (2010) ("[T]he full extent of such costs and the extent to which they will ultimately be paid by the Responsible Parties or federal, state, and local governments is unknown at this time and depends on a variety of factors.").

6. The offshore oil and gas industry's reaction is also strikingly different from the reaction of the United Kingdom, Norway, Australia, and Maritime Canada, all of whom have made major changes in their offshore drilling regulatory programs in response to accidents. *See* Nat'l Comm'n on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *A Competent and Nimble Regulator: A New Approach to Risk Assessment and Management* 10–16 (Staff Working Paper No. 21, 2011) [hereinafter Staff Working Paper No. 21], *available at* http://www.oilspillcommission.gov/sites/default/files/documents/A%20Competent%20and%20Nimble%20Regulator%20A%20New%20Approach%20to%20Risk%20Assessment%20and%20Management.pdf. In particular, the United Kingdom and Norway now combine both prescriptive regulations and performance requirements that force industry "to go well beyond simple compliance." *Id.*

7. *See* NAT'L COMM'N ON THE BP DEEPWATER HORIZON OIL SPILL AND OFFSHORE DRILLING, REPORT TO THE PRESIDENT, DEEP WATER: THE GULF OIL DISASTER AND THE FUTURE OF OFFSHORE DRILLING 235 (2011) [hereinafter COMMISSION REPORT], *available at* http://www.oilspillcommission.gov/sites/default/files/documents/DEEPWATER_ReporttothePresident_FINAL.pdf ("For the nuclear power industry, it took a crisis—the partial meltdown in 1979 of the radioactive core in Unit Two at Three Mile Island Nuclear Generating Station—to prompt a transformation of its safety culture."). *But see* Editorial, *In the Wake of Fukushima*, N.Y. TIMES, July 24, 2011, at SR11 (noting that "[t]here are already signs that the [nuclear]

diffident attitude before the accident at TMI-2 about the likelihood of a serious nuclear accident occurring, in the period following the accident, the nuclear industry and the NRC undertook significant changes to the regulations and cultural mores governing nuclear power plant operation—largely to regain the public's trust in nuclear power.[8] This Article explores why the respective approaches to managing risks in the deepwater drilling and nuclear industries, both of which engage in very risky activities[9] and exhibit some common structural and regulatory features,[10] have diverged.

The Article posits that, despite their similarities, there are three significant differences between the industries that influence how each has assessed the possible occurrence of a catastrophic accident, as well as the need to take pre-accident precautionary measures.[11] The first is that a nuclear accident has the potential to critically impact both local and distanced public health over a long period of time, while an accident on the outer continental shelf (OCS) principally affects the more distant marine environment,

industry and its allies among Congressional Republicans will press the [NRC] commissioners to bury the recommendations" issued by a task force formed in response to the accident at the Fukushima Daiichi nuclear plant).

8. *See* COMMISSION REPORT, *supra* note 7, at 229 ("The primary motivation for improving safety in each instance [referring to civilian aviation and nuclear-fueled electric power plants] is that neither the public (as consumers and as voters) nor the government would allow such enterprises to operate if they suffered many accidents.").

9. *See id.* at 235 ("The risk-management challenges presented by nuclear power are in some respects analogous to those presented by deepwater drilling: the dependence on highly sophisticated and complex technologies, the low probability/catastrophic consequences nature of the risks generated, and the related tendency for a culture of complacency to develop over time in the absence of major accidents.").

10. Both the deepwater drilling and the nuclear industries are subject to pre-construction and pre-operation safety and environmental reviews, each has the benefit of a statutory liability cap and substantial government subsidies, and each provides a product that is in high demand. *Cf. id.* at 239–40. However, there are also significant institutional differences between the industries. For example, there are a limited number of fixed nuclear power plant sites, and these sites use a limited number of well-established technological designs, all stages of which are highly regulated. By contrast, the oil and gas industry operates in many different locations and environments, employs different, continuingly evolving technologies and designs, and is highly fragmented, diversified, and protective of proprietary information. *Cf. id.* at 240–41.

11. *See id.* at 239–40 (noting among the similarities between the industries that the government "possess[es] sweeping authority to dictate the terms" of their actions and the performance of each can improve if effective private self-policing programs are initiated to supplement the over-worked, under-staffed, and technically disadvantaged government oversight programs that lack "technical expertise truly commensurate with that of private industry").

the visible effects of which are of relatively short duration. The second difference is that it is easier to defray the costs of an accident on the OCS, including the costs of subsequent mitigation and remediation measures, by passing them through to consumers than it is in the case of an accident at a nuclear power plant because state public service commissions control the rate of return that utilities make. If precedent is any guide, these state commissions will be unsympathetic to any future requests by a utility for post-accident monetary relief.[12] A final difference, less tangible but perhaps the most important, concerns the public fear of radiation. Put simply, the public is not afraid of oil. This perception makes it unlikely that the United States nuclear industry could withstand another serious accident,[13] while the deepwater drilling industry carries no analogous burden. Collectively, these differences have contributed to a higher standard of care in the nuclear industry, and also make it unlikely that the offshore oil and gas industry will naturally gravitate to the more cautious paradigm adopted by its nuclear counterparts without external pressure.[14]

To substantiate this thesis, Part I of the Article briefly sets out some background facts on each industry, including their accident records and a description of the most recent catastrophic accident in each industry—the *Deepwater Horizon* drilling rig explosion and the TMI-2 partial nuclear core meltdown. This Part demonstrates that major accidents on deepwater drilling rigs happen with greater frequency than at nuclear power plants. Part II discusses the direct

12. *See infra* note 376 and accompanying text (discussing the unwillingness of the Pennsylvania and New Jersey Public Service Commissions to pass on the costs of cleaning up TMI-2 to their customers).

13. The recent accident at the Fukushima Daiichi nuclear complex in Japan, which was severely damaged by an earthquake and tsunami in March of 2011, has reignited those fears, especially given that the design of those plants is similar to several domestic nuclear reactors. *See, e.g.*, Timothy Hurst, *Will Fukushima Pull a Vermont Nuclear Plant Off the Rails?*, REUTERS, Mar. 31, 2011, *available at* http://www.reuters.com/assets/print?aid=US156615525820110331 (noting that the Japanese plants "use[] the same General Electric boiling water reactors with Mark-1 containment vessels and above-ground spent waste storage pools as those at [the] Vermont Yankee [nuclear power plant] . . . ."); *Court Requires Exelon, NRC to Review Licensing of Oyster Creek Plant*, GREENWIRE (Mar. 22, 2011), http://www.eenews.net/Greenwire/2011/03/22/19 ("The Oyster Creek plant, like many other older plants in the United States, uses the same General Electric Mark 1 reactor design as the crippled Fukushima Daiichi plant in Japan.").

14. Indeed, the President's Oil Spill Commission suggested that the nuclear industry's transformation of its "culture of complacency" toward major accidents occurring was "a useful analogue" for the oil and gas industry, as it seeks to do the same thing. COMMISSION REPORT, *supra* note 7, at 235.

and indirect causes of the two accidents, revealing their remarkable similarities—indeed, shared causes that, to some, made both accidents "inevitable."[15] In Part III, the Article examines how the occurrence of catastrophic accidents has affected the way in which each industry assesses the likelihood of another accident and what, if any, precautionary steps they and their respective regulatory agencies have taken to avoid a recurrence. In Part IV, the Article discusses how differences in the type of harm that might result from an accident in one industry compares to the other, the importance of economic constraints, and how public perceptions about the ensuing harm influence each industry's risk avoidance decisions.

The Article concludes that, while the nuclear industry is far from perfect, the deepwater drilling industry could learn from the post-accident steps taken by its nuclear power counterparts—particularly those that involve rigorous internal and external auditing of activities, greater public transparency, and internal corporate restructuring that places responsibility for risky operations higher up the management ladder and makes operational safety a company priority.[16] While few doubt that there

15. *See* Russell Gold & Ben Casselman, *Far Offshore, a Rash of Close Calls*, WALL ST. J., Dec. 8, 2010, at A1 (saying the Macondo well blowout was "bound to happen"—perhaps not on that day or on that particular rig, but an accident of that magnitude was inevitable); *see also* JOHN G. KEMENY, THE PRESIDENT'S COMM'N ON THE ACCIDENT AT TMI, REPORT OF THE PRESIDENT'S COMMISSION ON THE ACCIDENT AT THREE MILE ISLAND 11 (1979) [hereinafter KEMENY COMMISSION REPORT], *available at* http://www.threemileisland.org/downloads/188.pdf (concluding that "while the major factor that turned this incident into a serious accident was inappropriate operator action, many factors contributed to the actions of the operators, such as deficiencies in their training, lack of clarity in their operating procedures, failure of organizations to learn the proper lessons from previous incidents, and deficiencies in the design of the control room. These shortcomings are attributable to the utility, to suppliers of equipment, and to the federal commission that regulates nuclear power. Therefore—whether or not operator error 'explains' this particular case—given all the above deficiencies, we are convinced that an accident like Three Mile Island was eventually inevitable.").

16. *See* Hope M. Babcock, *Corporate Environmental Social Responsibility: Corporate "Greenwashing" or a Corporate Culture Game Changer?*, 21 FORDHAM ENVTL. L. REV. 1, 59–68 (2010) (discussing ways to redesign corporate social responsibility programs to be more effective). Some recent indications of improved industry and NRC transparency are evident from public meetings NRC staff held in response to the Japanese nuclear plant disaster. *See* Hannah Northey, *NRC Plans Meetings to Discuss Reactors in N.Y., S.C.*, GREENWIRE (Mar. 21, 2011), http://www.eenews.net/Greenwire/print/2011/03/21/16. However, not all believe the progress in this area has been sufficient. For example, at a 2009 U.S. Senate subcommittee hearing, Gregory B. Jaczko, the Chairman of the NRC, noted a need for the NRC to improve its ability "to communicate in plain English . . . [when] we're communicating complex technical information in a way that the public can understand

will be technological improvements made in how oil and gas are extracted from deep water after the *Deepwater Horizon* accident,[17] the changes this Article recommends implicate how companies that engage in risky operations might improve their conduct from an accident avoidance perspective. However, due to the absence of a sustained public fear of the risks associated with deepwater drilling that might spark a social rethinking of the industry, it seems unlikely that the industry will undertake these steps.

I. BACKGROUND INFORMATION ON THE DEEPWATER DRILLING AND NUCLEAR INDUSTRIES

Both the deepwater drilling and nuclear industries occupy a critical place in meeting the country's dependence on energy,[18] and each requires that the companies engaging in these energy-producing activities, including the operating crews running the equipment, undertake significant risks. Not surprisingly, there have been serious accidents in each industry—the prevention and containment of which has grown increasingly complex. This Part of the Article briefly looks at these two industries, their respective accident records, the specific accidents that form the basis of this Article, and the human and environmental consequences of each of these accidents.

without necessarily having . . . a background in nuclear engineering or nuclear science." *See A Hearing on Three Mile Island—Looking Back on Thirty Years of Lessons Learned: Hearing Before the Subcomm. on Clean Air and Nuclear Safety of the S. Comm. on Env't and Pub. Works*, 111th Cong. 14 (2009) [hereinafter Senate Three Mile Island Hearing] (statement of Gregory B. Jaczko, Chairman, Nuclear Regulatory Comm'n). Peter A. Bradford, a former NRC Chairman, also complained to Congress that recent changes to the licensing process have lessened public access and brought to its attention the failure of the NRC to adopt a Kemeny Commission recommendation that the NRC create an Office of Special Counsel to represent the public at licensing hearings. *Id.* at 33 (statement of Peter A. Bradford, former Chairman, Nuclear Regulatory Comm'n).

17. William J. Broad, *Taking Lessons from What Went Wrong*, N.Y. TIMES, July 20, 2010, at D1 ("[T]he BP disaster, like countless others, will ultimately inspire technological advance.").

18. Americans consume 18.7 million barrels of petroleum products a day "to fuel our economy." COMMISSION REPORT, *supra* note 7, at viii; *see also* Carl Hoffman, *Investigative Report: How the BP Oil Rig Blowout Happened*, POPULAR MECHANICS, Sept. 2, 2010, http://www.popularmechanics.com/science/energy/coal-oil-gas/how-the-bp-oil-rig-blowout-happened?page=all ("Oil and gas leases are the federal government's second largest source of revenue, after income taxes."); *infra* notes 97–98 and accompanying text (describing the role of nuclear power in meeting the country's energy needs).

A. The Oil and Gas Industry

Since the federal government sold the first leases for offshore hydrocarbon rights in the Gulf of Mexico in 1954[19] under the auspices of the Outer Continental Shelf Lands Act,[20] over fifty thousand wells have been drilled there.[21] Four thousand of these wells have been drilled at depths greater than one thousand feet, with seven hundred located deeper than five thousand feet.[22] Today, more than seventy percent of all offshore oil and gas production comes from these giant deepwater drilling platforms.[23]

Offshore oil and gas leasing, which had expanded rapidly both in the number of wells drilled and in the areas developed in early years, slowed significantly after a well blowout in the Santa Barbara Channel in 1969 and was thereafter restricted to the Gulf,[24] where it is largely concentrated today.[25] Interior Secretary James G. Watt attempted to reinvigorate the offshore leasing program in the 1980s,[26] but his efforts triggered negative reactions in states and localities that had not previously been subject to the program.[27]

19. Kim Harb, *The Legal and Policy Dilemma of Offshore Oil and Gas Development*, NAT. RESOURCES & ENV'T., Summer 2004, at 23, 24. For a more detailed discussion of the history of offshore oil and gas development, including the trend toward deepwater drilling, see COMMISSION REPORT, *supra* note 7, at 21–53.

20. Outer Continental Shelf Lands Act, 43 U.S.C. §§ 1331–1356 (1953) (amended 1975, 1978, 1986, 1990, 1992, 1994, and 1995).

21. Clifford Krauss & John M. Broder, *Spotlight Shifts to Shallow-Water Wells*, N.Y TIMES, Sept. 3, 2010, at B1.

22. *Id.*

23. *Id.* ("Although more than 70 percent of all offshore oil production now comes from jumbo oil platforms plumbing the gulf's deeper waters . . . [c]urrently, 3,333 platforms are drilling in depths of less than 500 feet, compared with just 74 in deeper waters").

24. *See* Harb, *supra* note 19, at 24–25 (explaining that rapid expansion of offshore leasing stopped after "a dramatic blowout from an offshore rig caused the accidental release of more than seventy-one thousand barrels of oil into the Santa Barbara channel, fouling wildlife and miles of California coastline," which resulted in "the immediate cancellation of additional lease sales in the Pacific region for five years, and in the postponement of some initial sales in the Alaska and Atlantic regions. In Congress, the momentum of this outcry resulted in the passage of several new laws over the next few years, including the National Environmental Policy Act and the Coastal Zone Management Act." (citations omitted)).

25. This may change because of recent efforts by the Obama administration to expand offshore drilling—e.g., the recent grant of an air quality permit to Shell for a drilling vessel operating in Alaska. *See* Dan Joling, *Shell Gets EPA Permit for Exploratory Drilling in Arctic*, ANCHORAGE DAILY NEWS, Sept. 20, 2011, http://www.adn.com/2011/09/19/2077026/shell-gets-epa-permit-for-arctic.html.

26. *Id.* at 25 (explaining that Interior Secretary Watt took the area-wide leasing program that had been successfully applied in the Gulf and applied it to the entire OCS during the early 1980s).

27. *Id.*; *see also* Ben Lieberman, *Congressional Moratorium on Offshore Drilling in the Outer*

Congress responded with annual appropriation riders to limit the areas of the OCS that could be leased, and a moratorium by the Bush administration followed in 1990.[28] At the present time, eighty-five percent of the OCS is closed to oil and gas development—removing from potential production 19.1 billion barrels of oil, the equivalent of thirty years of current imports from Saudi Arabia.[29] These restricted areas cover nearly the entire coasts of the Pacific and Atlantic oceans, as well as the eastern Gulf of Mexico and Alaska.[30] Offshore drilling in the rest of the Gulf, however, developed at a record pace following the 1990 moratorium.[31] This increase in drilling activity in the Gulf, involving wells that were more technically complex and further from shore, coincided with the budget of the Minerals Management Service (MMS), the agency within the Department of the Interior charged with issuing offshore leases for the development of oil and gas on the OCS and regulating activities on those leases, reaching its "nadir."[32]

Although the April 20, 2010 blowout of the Macondo well and the resulting fire on the *Deepwater Horizon* oil rig is, to date, the worst accident at a deepwater drilling platform since the federal government authorized offshore drilling, it was not the first accident on such a drilling rig to have a catastrophic environmental

Continental Shelf Should Be Allowed to Expire, THE HERITAGE FOUND. (Aug. 8, 2008), http://www.heritage.org/research/reports/2008/08/congressional-moratorium-on-offshore-drillin g-in-the-outer-continental-shelf-should-be-allowed-to-expire ("Beginning in 1982, Congress restricted more and more areas through annual Department of the Interior (DOI) appropriations.").

28. Harb, *supra* note 19, at 25 (describing the use of annual appropriation riders to withdraw huge areas of the OCS from development, followed by a moratorium); *see also* Lieberman, *supra* note 27. In 1990, President George H.W. Bush issued a presidential directive withdrawing new areas from offshore exploration and drilling. These White House restrictions overlapped with the congressional restrictions. In 1998, President Clinton extended these restrictions through 2012. However, in response to rapid increases in gasoline prices, President George W. Bush rescinded them in 2008. *Id.*

29. Lieberman, *supra* note 27 (referencing recent DOI estimates); *see also* Erica Werner, *Feds: Minimum Impact from Drilling Moratorium*, BUSINESSWEEK (Sept. 16, 2010, 6:13 AM), http://www.businessweek.com/ap/financialnews/D9I8URK81.htm ("[T]he U.S. consumed more than 7 billion barrels of oil in 2008.").

30. Harb, *supra* note 19, at 23. A recent post-*Deepwater Horizon* accident moratorium was lifted in October 2010. *See* discussion *infra* note 313.

31. *See* Staff Working Paper No. 21, *supra* note 6, at 3 n.4 (reporting that "a record number of wells were drilled in 1997," due in part to the relatively greater amount of oil than natural gas in deepwater reservoirs, ensuring higher profits for rig operators despite the higher production costs).

32. *Id.* at 3.

impact. The 1969 accident in the Santa Barbara Channel lasted for eleven days and released between eighty and one hundred thousand barrels of oil into the channel, killing wildlife and coating an estimated thirty miles of California coastline with oil.[33] In 1970, a Chevron well in the Gulf blew out and caught fire, damaging wildlife and drawing million dollar lawsuits from Louisiana oyster and shrimp fishermen;[34] months later, a Shell blowout followed, killing four men and injuring thirty-seven more.[35] In 1979, *IXTOC I*, a Mexican exploratory well two miles deep in the Bay of Campeche (six hundred miles south of Texas) blew out, spilling 3.5 million barrels of oil[36] and affecting miles of Texas coastal barrier beaches.[37] Oil from that well continued to spew for ten months, making it the second largest oil spill in history.[38]

In fact, well blowouts are not rare events at all.[39] Between 1964 and 2001, blowouts in the Gulf of Mexico occurred on average once every 3.7 years.[40] A total of sixty-six blowouts have occurred in

33. COMMISSION REPORT, *supra* note 7, at 28. Ironically, the well's blowout preventer worked, but poor well design allowed oil to escape from "near-surface ruptures beneath the seafloor." *Id.* Prior to the blowout, Union Oil Company, the owner of the platform, had received a waiver from the U.S. Geological Survey that allowed it to set casings at a shallower depth than required. *Id.*

34. *Id.* at 29–30.

35. *Id.* After the Shell blowout, it "took 136 days to bring 11 wild wells under control, at a cost of $30 million." *Id.* at 30.

36. *Sedco 135F - IXTOC I*, OIL RIG DISASTERS, http://home.versatel.nl/the_sims/rig/ixtoc1.htm (last visited Nov. 2, 2011) (providing data on the *IXTOC I* disaster).

37. *See* Gladwin Hill, *Ixtoc's Oil Has a Silver Lining*, AUDUBON, Nov. 1979, at 150, 154.

38. *Incident News: IXTOC I*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., http://www.incidentnews.gov/incident/6250 (last visited Dec. 4, 2011); *see also Incident News, IXTOC I Well Blowout*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. (Feb. 14, 2007), http://www.incidentnews.gov/entry/517477 ("IXTOC I is currently #2 on the . . . list of largest oil spills of all-time, eclipsed only by the deliberate release of oil, from many different sources, during the 1991 Gulf War."). Other major accidents have occurred in the North Sea, in the Atlantic Ocean off of Newfoundland, and in the Atlantic Ocean off of Brazil, where the world's largest oil rig blew up and sank, killing ten people. Although these accidents caused little environmental damage, they did result in loss of life. *See, e.g., World's Largest Oil Rig Sinks*, REUTERS, Mar. 20, 2001, *available at* http://www.commondreams.org/headlines01/0320-02.htm.

39. *See* William Campbell, *Delving Into Deepwater—Before the Blow-Out, in* MARITIME ACCIDENT CASEBOOK (2009), *available at* http://maritimeaccident.org/2010/07/delving-into-deepwater-before-the-blow-out ("World-wide since 1955 and prior to [the blowout of] Deepwater Horizon there have been 44 notable blowout events causing 79 deaths, with significant loss of assets and one event in 1979 causing massive pollution. In this period . . . the mean time between blowouts was 15 months.").

40. *See* Campbell, *supra* note 39 (stating that in the thirty-seven year period between 1964 and 2001, the Gulf of Mexico experienced "10 blowouts or 23% of the world-wide events. This resulted in 27 deaths or 34% of the deaths world-wide. One event, the blowout on the

the Gulf's offshore drilling history, killing twenty-nine workers since 1979.[41] Between 1964 and 2009, there has been a "steady stream" of smaller spills from blowouts, ruptured pipelines, and tanker leaks that have dumped approximately 517,847 barrels of oil into the Gulf of Mexico, killing thousands of birds and soiling beaches as far away as Mexico's Yucatan Peninsula.[42] Taken together, these accidents have released double the amount of oil into U.S. waters as the *Exxon Valdez* tanker released when it ran aground on Bligh Reef in 1989.[43] In light of this record, statements by the industry that its safety record is exemplary[44] seem "tantamount to deception."[45]

Semi-submersible Sedco 135F[,] caused pollution into the gulf of an estimated 455 to 480,000 tonnes of oil."). By comparison, over a fifty-five year period, British offshore operations in the North Sea have experienced only two blowouts. *Id.*

41. Gayathri Vaidyanathan, *Offshore Drilling: Gulf Blowouts the Norm for Decades Due to Lax Regulation*, GREENWIRE (July 20, 2010), http://www.eenews.net/Greenwire/print/2010/07/20/6 ("Subterranean plumes of gas have erupted 66 times in the Gulf of Mexico in recorded history, killed 29 drillers since 1979 and prompted numerous federal calls for investigations and improvements. All went unheeded by the industry . . . ."); *see also* COMMISSION REPORT, *supra* note 7, at 3 ("Since 2001, the Gulf of Mexico workforce—35,000 people working on 90 big drilling rigs and 3,500 production platforms—had suffered 1,550 injuries, 60 deaths, and 948 fires and explosions.").

42. Steven Mufson, *Federal Records Show Steady Stream of Oil Spills in Gulf Since 1964*, WASH. POST, July 24, 2010, http://www.washingtonpost.com/wp-dyn/content/article/2010/07/23/AR2010072305603.html?wpisrcenl_headline.

43. *Id.* (noting, in addition, that federal records "tell a different story" from that told by Interior Secretary Ken Salazar, who is quoted as saying that the industry's "history of safety" in the Gulf of Mexico has provided the "'empirical foundation' for U.S. policy").

44. *Id.* (quoting American Petroleum Institute President Jack Gerard as saying, "The oil industry has drilled 42,000 wells in the Gulf of Mexico, and this is the first time an incident of this magnitude has happened," and further noting that the "BP oil spill is the biggest ever, but MMS records tell a more complicated story. Performance had been improving but from a poor baseline."). Furthermore, conditions appear to have worsened in the years immediately preceding the Macondo well blowout. According to data collected around the world, after years of showing improvement, the deepwater drilling industry's safety record suddenly deteriorated between 2008 and 2010. *See* Russell Gold & Ben Casselman, *Far Offshore, a Rash of Close Calls*, WALL ST. J., Dec. 8, 2010, http://online.wsj.com/article/SB10001424052748703989004575652714091006550.html (noting that in the U.S. portion of the Gulf of Mexico in 2009 there were "28 major drilling-related spills, natural gas releases or incidents in which workers lost control of a well . . . up 4% from 2008, 56% from 2007, and nearly two-thirds from 2006."). There are many possible reasons for this decline in the industry's safety record, including problems finding and retaining enough experienced workers, the difficulty of balancing "safety priorities with profit demands," and "occasional lapses in the face of lax regulation." *Id.*

45. Campbell, *supra* note 39 (referring to industry statements that "blowouts could be discounted from the decision to drill into deepwater formations because they were rare events"). Campbell also discusses what is considered a tolerable level of risk in offshore drilling in the United Kingdom: "1 in 100 or 1 in 1000 years depending on the event and its

Even without the occurrence of accidents of the same magnitude as those mentioned above, the environmental impacts of oil and gas development on the OCS are sufficiently significant to warrant public concern. "There are over 5,600 offshore oil and gas platforms in the United States and over 27,000 miles of pipelines in the areas of the Gulf of Mexico already open to drilling," which have permanently destroyed deep water habitats[46] and constitute a major source of air pollutant emissions in the Gulf.[47] Each year, drilling operations in this country deposit "an average of 880,000 gallons of oil into the ocean."[48] That number can drastically increase in years with significant hurricane activity—for example, in 2005, "[h]urricane damage caused at least 124 different spills, totaling over 17,700 barrels (743,000 gallons) of petroleum products."[49] In addition to oil spills, drill cuttings, which are contaminated with "drilling fluid used to lubricate and regulate the pressure in drilling operations," contain toxic petroleum products and heavy metals that are dumped into the ocean.[50] Ocean currents can carry contaminated bottom sediments miles from the drilling rig, diminishing populations of small bottom-dwelling marine life that play a critical role in the marine food chain and

potential consequences," a "far cry" from the average blowout frequency of 1 every 3.7 years witnessed in the Gulf of Mexico from 1964 to 2001, or even the new average of 1 every 4.2 years since the *Deepwater Horizon* incident. *Id.* One explanation for this apparent decrease in the rate of incidents may be the industry's successful efforts to weaken incident reporting requirements. *See* Staff Working Paper No. 21, *supra* note 6, at 5–7 (describing these efforts and how the offshore oil and gas industry cited the limited voluntary data as proof that "the rate of incidents has significantly decreased since 1996" due to "operators focusing on safety and protecting the environment").

46. *Outer Continental Shelf Drilling*, DEFENDERS OF WILDLIFE, http://www.defenders.org/resources/publications/policy_and_legislation/impacts_of_outer_continental_shelf_drilling.pdf (last visited Nov. 2, 2011), at 1.

47. *See id.* ("Oil and gas activities account for the overwhelming majority of air pollutants: 89% of carbon monoxide, 77% of NO_x emissions, 72% of volatile organic compound emissions, 69% of particular matter emissions, and 66% of sulfur dioxide."). More than 200,000 birds die annually as a result of colliding with these oil and gas platforms, and marine mammals and sea turtles can collide with support vessels. *Id.* at 2. Further, onshore pipelines can "damage sensitive coastal habitats and marshes." *Id.*

48. *Id.* at 1. Oil is highly toxic to wetland grasses, submerged aquatic vegetation, birds, terrestrial and marine mammals, fish, and microscopic animals at the base of the marine food chain. *Id.* Oil can also damage tissues in the eyes, mouth, skin, and lungs of marine mammals. *Id.* at 2.

49. *Id.*; *see also* Oliver A. Houck, *Worst Case and the Deepwater Horizon Blowout: There Ought To Be a Law*, 40 ENVTL. L. REP. NEWS & ANALYSIS 11033, 11037 (2010) (noting that Hurricanes Katrina and Rita spilled approximately eleven million gallons of oil into the Gulf).

50. DEFENDERS OF WILDLIFE, *supra* note 46, at 1.

"biomagnifying toxic contaminants in fish we eat."[51]

Further, noise generated by seismic surveys conducted during oil and gas exploration can permanently harm the hearing of marine mammals, inducing them to change their behavior, and can even physically injure them.[52] Construction noise from drilling rigs and pipelines can disrupt foraging and communication behaviors of birds and marine mammals.[53] Noise, collisions, and dredging of nesting beaches in connection with the laying of pipelines all threaten the continued viability of sea turtles.[54] The apparent indifference of the general public to all of these impacts may be due to the fact that it is largely unaware of what is happening.

1. The *Deepwater Horizon* Accident and Macondo Well Blowout

> Already this oil spill is the worst environmental disaster America has ever faced. And unlike an earthquake or a hurricane, it's not a single event that does its damage in a matter of minutes or days. The millions of gallons of oil that have spilled into the Gulf of Mexico are more like an epidemic, one that we will be fighting for months and even years.[55]

The Macondo well was the first well that British Petroleum (BP)[56] began to drill in Mississippi Canyon Block 252—a nine-square-mile plot in the Gulf of Mexico.[57] The company knew little about the geology of the lease block and planned to drill the well to twenty

51. *Id.*

52. *Id.*

53. *Id.*

54. Sea turtle hatchlings are even more vulnerable to oiling than adult turtles because they float near the water surface, where spilled oil and tar balls accumulate. *Id.*

55. President Barack Obama, Remarks by the President to the Nation on the BP Oil Spill, (June 15, 2010), *available at* www.whitehouse.gov./thepress-office/remarks-president-nation-bp-oil-spill.

56. In 2010, BP produced more than four million barrels of oil a day from thirty countries. COMMISSION REPORT, *supra* note 7, at 2.

57. The *Deepwater Horizon* drilling rig, which had been under contract to BP since its first voyage in 2001, cost $350 million to build. *Id.* BP paid a little more than thirty-four million dollars to the Department of the Interior for "an exclusive lease" to drill in Mississippi Canyon Block 252. *Id.* at 89. Seven months prior to the accident, the rig had drilled a 35,055-foot well—at that point the world's deepest well. Hoffman, *supra* note 18, at 3. The rig was actually the second Transocean rig that worked on the Macondo well; an earlier rig started drilling in October 2009, reaching a depth of 9,090 feet before it was moved offsite to avoid Hurricane Ida, which nonetheless caused sufficient damage to the rig that the *Deepwater Horizon* rig was brought in as a replacement. COMMISSION REPORT, *supra* note 7, at 92.

thousand feet to learn more.[58] It had expectations that the results of this exploration effort would be a production well capable of generating a large profit for the company.[59] Instead, in a little more than two years, as a result of the blowout, BP found itself paying tens of billions of dollars to contain and mitigate the damage from the spilled oil and compensate hundreds of thousands of individuals and businesses that had been harmed by it.[60]

The Macondo well failed in a "complex way" in part because drilling an exploratory well in deep water is a "complex operation."[61] Although there was no single cause of the *Deepwater Horizon* accident[62]—or, as a *Washington Post* columnist put it, there is "no smoking gun" because "smoke is coming from so many places"[63]—the immediate cause of the blowout was a failure to contain hydrocarbon pressure in the well.[64] Immediately preceding the blowout, a cement plug at the bottom of the well failed, allowing gas to escape into and up the pipe beyond the blowout preventer so that it could not shut down the well.[65] This failure, an

58. COMMISSION REPORT, *supra* note 7, at 89. At the time of the accident, the Macondo well was being drilled 5,000 feet through Gulf water, and then 13,000 feet under the sea floor to the underlying hydrocarbon reservoir. *Id.* at viii.

59. *Id.* at 89.

60. *Id.* at 89–90.

61. *See* Joel Achenbach & David Hilzenrath, *As Federal Panel Probes Oil Spill, Picture Emerges of a Series of Iffy Decisions*, WASH. POST, July 25, 2010, at A1, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2010/07/24/AR2010072402594_2.html?hpid=topnews&sid=ST2010072305432 ("[I]t is increasingly clear that the complex operation of drilling an exploratory well in the deep water of the Gulf of Mexico failed in a complex way.").

62. *But see* COMMISSION REPORT, *supra* note 7, at vii ("The immediate causes of the Macondo well blowout can be traced to a series of identifiable mistakes made by BP, Halliburton, and Transocean that reveal such systematic failures in risk management that they place in doubt the safety culture of the entire industry."); Staff Working Paper No. 21, *supra* note 6, at 10 ("[L]axity in regulation and data collection appears to have caused deterioration in the safety culture of the Gulf").

63. Achenbach & Hilzenrath, *supra* note 61.

64. COMMISSION REPORT, *supra* note 7, at 115.

65. SENATOR BOB GRAHAM & WILLIAM K. REILLY, NAT'L COMM'N ON THE BP DEEPWATER HORIZON OIL SPILL AND OFFSHORE DRILLING, CHIEF COUNSEL'S REPORT, MACONDO: THE GULF OIL DISASTER 95 (2011) [hereinafter CHIEF COUNSEL'S REPORT] ("It is undisputed that the primary cement at Macondo failed to isolate hydrocarbons in the formation from the wellbore—that is, it did not accomplish zonal isolation. If the cement had set properly in its intended location, the cement would have prevented hydrocarbons from flowing out of the formation and into the well. The cement would have been a stand-alone barrier that would have prevented a blowout even in the absence of any other barriers (such as closed blowout preventer rams, drilling mud, and cement plugs).").

unstable well design, and a series of missed opportunities and mistakes set off a chain of events that culminated in gas and drilling muds reaching the drilling rig deck.[66] By that time, it was too late to activate the blind shear rams in the blowout preventer, which would have closed the well, or to divert the arriving mud and gas over the side of the rig.[67] Either one of these steps might have reduced the risk of igniting the rising gas.[68] Instead, the escaped gas from the top of the well ignited and produced a series of explosions, which quickly led to a massive fire. The rig was destroyed and sank, and eleven crew members lost their lives.[69]

The *Deepwater Horizon* accident lasted for 152 days and spilled nearly five million barrels of oil into the Gulf before the well was finally plugged in September—two months after BP capped the well.[70] The oil spread to the eastern Gulf and Pensacola, Florida (as well as to other areas of Florida's western shoreline), and occasional tar balls floated as far west as Texas' coastline.[71] The spill's immediate impact on the marine environment was devastating; as of November 1, 2010, wildlife responders had collected 8,183 oiled birds, 1,444 endangered sea turtles, and 109 marine mammals.[72] Some of these animals were dead,[73] and others will likely have shortened life spans.[74] Nesting areas for birds[75] and

66. *See generally* COMMISSION REPORT, *supra* note 7, at 89–122 (describing the events leading up to the accident).

67. *Id.* at 121. The Commission Report estimates that the explosion occurred six to eight minutes after the muds started spilling on the rig floor. *Id.* at 122.

68. *Id.* at 121.

69. For a chronological description of the accident and the events that occurred on the rig, see *id.* at 1–19.

70. For a detailed description of the various attempts to "kill" the well and stop the flow of oil permanently, see *id.* at 169. The well was finally plugged on September 19, 2010, five months after the explosion occurred and two months after the company capped the well, stopping the flow of oil and gas into the Gulf. *See id.* (discussing the capping and sealing of the well). Oil actually stopped flowing from the well in mid-July. *Id.*; *see also* Henry Fountain, *Once Well Is Fully Sealed, BP May Go Back for More*, N.Y. TIMES, Sept. 19, 2010, http://query.nytimes.com/gst/fullpage.html?res=940CEFDA143CF93AA2575AC0A9669D8B63 (noting that after the valves closed on a new cap at the top of the well in mid-July, oil stopped flowing into the Gulf).

71. COMMISSION REPORT, *supra* note 7, at 177 (describing the reach of the spilled oil).

72. *Id.* at 181.

73. For example, 100 of 109 marine mammals collected were dead, most of which were bottlenose dolphins. Over 600 of 1,144 collected sea turtles were also dead. *Id.*

74. *Id.* With sixty percent of the data verified, the three "most affected" bird species appear to be Brown Pelicans, Northern Gannets, and Laughing Gulls. *Id.* There will also be "sub-lethal effects" and impacts from the oil "on future populations." *Id.* *But see* Leslie Kaufman & Sheila Dwan, *Oiled Gulf May Defy Direst Predictions*, N.Y. TIMES, Sept. 14, 2010, at

sea turtles[76] were likely destroyed, as were food sources for many of the affected species.[77] Oyster beds were damaged and closed, and the long-term impact on oysters (a "keystone species"),[78] blue crabs, and other shellfish, as well as their larvae, has yet to be determined.[79] Several large estuarine-dependent fish species,

D1 (reporting that oil damage to wildlife and Gulf habitat has so far been less than predicted and less than what resulted from the *Exxon Valdez* spill, but noting that many of these findings are contested); *Gulf Spill Compensation Administrator's Report Predicts Quick Recovery for the Gulf*, GREENWIRE (Feb. 2, 2011), http://www.eenews.net/Greenwire/2011/02/02/archive/20 (predicting that the Gulf should largely recover from the effects of the oil spill by 2012, including catches for blue crab, shrimp, oysters and finfish, although some oyster beds "could take six to 10 years to recover," and there will be fewer fish, shrimp, and crabs in some areas of the Gulf).

75. *Audubon Scientists Find Gulf Birds and Oil Too Close for Comfort*, BIRD LIFE INT'L, http://www.birdlife.org/community/2010/10/audubon-scientists-find-gulf-birds-and-oil-too-close-for-comfort (last visited Nov. 2, 2011); Alisa Opar, *Oil Spill Update: First Oiled Birds Released Today, Containment Setbacks, Media Copters Disturb Nesting Birds*, AUDUBON MAGAZINE BLOG (May 10, 2010), http://magblog.audubon.org/oil-spill-update-first-oiled-birds-released-today-containment-setbacks-media-copters-disturb-nesting ("Oil washed ashore on the Chandeleur Islands last week. The uninhabited barrier islands are part of the Breton National Wildlife Refuge and important nesting and breeding areas for many bird species.").

76. NAT'L MARINE FISHERIES SERVS., SUMMARY TOTALS (2011), *available at* http://www.nmfs.noaa.gov/pr/pdfs/oilspill/species_data.pdf; THE ENCYCLOPEDIA OF EARTH, *Sea Turtles and the Deepwater Horizon Oil Spill*, http://www.eoearth.org/article/Sea_turtles_and_the_Deepwater_Horizon_oil_spill (last visited Nov. 2, 2011).

77. "The Macondo well blowout oiled over 650 miles of Gulf Coast habitats, including salt marsh, mudflats, mangroves, and sand beaches," and "Louisiana's 'fragile delta habitats' bore the 'brunt of the damage.'" COMMISSION REPORT, *supra* note 7, at 176–77 (describing the ecological importance of these areas for a variety of species); *see also* LYNNE CORN & CLAUDIA COPELAND, CONG. RESEARCH SERV., THE DEEPWATER HORIZON OIL SPILL, COASTAL WETLANDS, AND WILDLIFE IMPACTS AND RESTORATION 13 (2010) ("The list of species that are likely to have direct mortality or indirect effects from loss of food, nesting habitat, and the like includes many fairly well-known species: piping plovers, least terns, five species of sea turtles, the American crocodile, three species of whales, manatees, and three species of sturgeon."); Melanie Driscoll, *Effects of Deepwater Horizon BP Oil Spill Still Visible One Year Later*, AUDUBON MAGAZINE BLOG (Apr. 13, 2011), http://magblog.audubon.org/effects-deepwater-horizon-bp-oil-spill-still-visible-one-year-later ("So it must be 2011. Because there is oil thick in some of those marshes, and there are tar balls strewn by wavelets across miles and miles of beach. And as the temperature climbs, the oil in the system is softening, liquefying, oozing, bubbling up from within the contaminated sands and soils of the central Gulf. As the oil liquefies, it will again coat the feathers of birds, many of them lightly enough that they will still be able to fly, fish, preen, and incubate eggs. These oiled birds will ingest some oil, which still contains harmful chemicals. They will still suffer more stress in trying to clean and waterproof those compromised feathers. Some of them will still carry oil back to their nests, oiling eggs and nestlings, perhaps causing slower growth, deformities, or even death among the sensitive chicks. Some birds may not find enough food for their young to survive, if enough invertebrates, fish or crustaceans died or left the spill-contaminated waters.").

78. A "keystone species" is "an organism that exerts a disproportionate influence on its habitat and community." COMMISSION REPORT, *supra* note 7, at 178.

79. *Id.* at 178–80.

including a wide variety of sharks, game fish, such as swordfish, marlin, and tuna, and many important Gulf fish, such as red snapper, grouper, black drum, and mahi-mahi, may have been affected by the spill.[80] The spill also blanketed approximately forty percent of the offshore waters used by larvae of the northern Gulf-estuarine dependent species,[81] and may have affected twenty percent of bluefin tuna larvae in 2010, "further placing at risk an already severely overfished species."[82]

Many wetland areas and beaches remained oiled long after the well was capped.[83] Nearly eight months after the spill, a centimeter-thick residue of oil still covered large areas of the deep-sea floor in the vicinity of the blowout, continuing to kill bottom-dwelling creatures like worms.[84] Although the actual amount of oil remaining in the water was disputed in the days following the accident,[85] there was no dispute about the "underwater plume of

80. *Id.* at 178. Many of these species have been tagged with tracking devices so that scientists can learn how the spill may have affected them. *Id.* at 180–81.

81. *Id.* at 178.

82. *Id.* at 181.

83. *See* Mark Schleifstein, *BP Reneges on Deal to Rebuild Oyster Beds, Repair Wetlands, Louisiana Officials Say*, NEW ORLEANS TIMES-PICAYUNE, Feb. 21, 2011, http://www.nola.com/news/gulf-oil-spill/index.ssf/2011/02/bp_reneges_on_deal_to_rebuild.html [hereinafter Schleifstein, *BP Reneges on Deal*] (reporting that "new tar balls" were washing up on a popular Louisiana Gulf Coast beach and subsurface sand samples from the beach revealed carcinogens, including benzene, xylene, and toluene). Oil mat in the nearshore subtidal zone has repeatedly "coagulat[ed]," providing a new supply of oil). *Id.* Cleanup contractors and natural resources officials have reported that "there's still a lot of oil buried back in the marshes where it was carried during high water events," and "[t]he threat [to coastal beaches and marshes] is absolutely still there and the oil is absolutely still there." *Id. See also* Mark Schleifstein, *Gulf of Mexico Oil Spill Continues to Foul 168 Miles of Louisiana Coastline*, NEW ORLEANS TIMES-PICAYUNE, Dec. 30, 2010, http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/12/gulf_of_mexico_oil_spill_conti.html.

84. *Oil Stains Seabed Deep Underneath Gulf of Mexico*, GREENWIRE (Dec. 9, 2010), http://www.eenews.net/Greenwire/print/2010/12/09/18 ("Scientists have reported centimeters-thick residue on the deep-sea floor that they suspect is oil . . . [and] sea animals, such as worms that crawl on the floor, appear dead."); *see also* COMMISSION REPORT, *supra* note 7, at 182 (saying that there were "unconfirmed reports" of oil deposits on the floor of the ocean near the Macondo well, as well as "recent reports of dead or dying deepwater corals"); Staff Working Paper No. 3, *supra* note 4, at 29 (noting the lack of evidence of "systematic oxygen drawdown" indicates that "rapid biodegradation might not be occurring"). A June 2010 study found "subsea plumes in the vicinity of the Macondo well that included high concentrations of natural gas," which appeared to be biodegrading faster than the oil plume. *Id.* at 26.

85. *See* Staff Working Paper No. 3, *supra* note 4, at 17–21 (concluding that initial statements by the federal government reflected in the Oil Budget of the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) that three quarters of the spilled oil was essentially "gone" created a misleading

hydrocarbons" in the vicinity of the spill, which the President's Oil Spill Commission calculated to be "35 kilometers long, 200 kilometers high, and 2 kilometers wide, at a depth of approximately 1,100 meters."[86] The release of toxic chemicals with the spill and the use of chemical dispersants at the well site may yet have an adverse effect on the deep-sea ecosystem.[87] Oil droplets remained in the water column and spots of oil could be observed on the sea floor as late as August 2011, even though little surface evidence of the spill could be seen in the Gulf and the immediate shoreline appeared cleaner.[88]

The closing of vast areas of the Gulf to fishing, the pall that remained over the safety of Gulf fish and shellfish after fishing, crabbing, and shrimping resumed, and the effect on tourism in an area that heavily depends on it[89] devastated the region's economy.[90] The social and psychological toll on families, especially children, who had only recently recovered from Hurricanes Katrina and Rita, is also expected to be great.[91] Tribal and immigrant fishing

impression).

86. *Id.* at 29.

87. It is unknown how quickly toxic chemicals like polycyclic aromatic hydrocarbons (PAHs), which can kill animals, disperse. A research team from Oregon State University "reported finding PAHs in the region 40 times higher than before the spill in September." *Toxic Chemicals Found in Deep Waters After Spill*, GREENWIRE (Nov. 3, 2010), http://www.eenews.net/Greenwire/print/2010/11/03/22. In May 2010, PAHs were found at depths of 3,300 feet and eight miles away from the leaking well. *Id.*

88. *See Oil Stains Seabed Deep Underneath Gulf of Mexico*, *supra* note 84 (stating that while the "exact amount of the oil remains unclear . . . there are spots spread across several thousand square miles of the sea floor"); *see also* Susanne Pagano, *Georgia Study Contradicts Federal Estimates of Oil Remaining from BP Spill in Gulf*, 41 ENV'T REP. 1869, 1894 (2010) ("Up to 79 percent of the oil released into the Gulf of Mexico by the Deepwater Horizon well has not been recovered and remains a threat to the ecosystem, researchers at the University of Georgia and the Georgia Sea Grant program said in a study released Aug. 17.").

89. COMMISSION REPORT, *supra* note 7, at 186 (describing the Gulf as "the hardest working of our ocean basins," producing in excess of one-third of the country's domestic seafood, "including most of the shrimp, crawfish, blue crabs, and oysters," "one-third of all domestic oil," and containing "four of the top seven trading ports by tonnage;" while the northern Gulf provides "diverse fish nursery and feeding grounds in the form of expansive marshes, mangrove stands, swamp forests, and seagrass beds, and hosts some of the best beaches and waters in the United States for recreation and tourism").

90. *See id.* at 187–88 (stating that closing 32,000 square miles of the Gulf to fishing created great uncertainty about the safety of Gulf fish and the public health risk of consuming them, and public exposure to the spill and its impact on marine species caused "reputational damage" to "Gulf seafood as a safe brand"). The spill severely affected the Gulf Coast's estimated annual $19.7 billion tourism industry, even in unoiled areas. *Id.* at 191.

91. *See id.* at 191–93. Surveys of Gulf Coast residents indicated a twenty-five percent increase in medically diagnosed depression and revealed a spike in calls to domestic violence

communities have been especially hard hit.[92]

The extent of the long-term damage to wildlife populations, especially to endangered species, and the capacities of the Gulf ecosystems to restore themselves are unknown,[93] as are the capacities of Gulf Coast communities to rebuild and recover economically.[94] What is known, however, is that the impact of the oil spill will outlast the cleanup efforts and other visible reminders of the accident; as one professor of oceanography stated: "These things reverberate through the ecosystem .... It is an ecological echo chamber, and I think we'll be hearing the echoes of this, ecologically, for the rest of my life."[95]

hotlines after the rig explosion. *Id.* at 193.

92. *See id.* at 193–94.

93. The Department of the Interior and others are continuing to study the potential impact of the spill on migratory birds and other wildlife that rely on Louisiana's coastal marshes. *Id.* at 181. A recent, controversial study by the Associate Director of Texas A&M's Harte Research Institute undertaken for the oil spill compensation fund concluded that the Gulf will recover from the effects of the spill by the end of 2012, although full recovery of oyster beds may take from six to ten years longer. John Schwartz & Mark Schrope, *Report Foresees Quick Gulf of Mexico Recovery from Spill Damage*, N.Y. TIMES, Feb. 2, 2011, at A15; *see also* John Schwartz & Mark Schrope, *On Gulf Oil Spill Effects, Doing Science with a Deadline*, N.Y. TIMES, Feb. 3, 2011, at A19 (reporting on criticisms of the report and its author and acknowledging that it was based on available data at the time it was written).

94. Curt Anderson, *Long, Costly Legal Battle Looms*, GREENWIRE (July 27, 2010), http://www.eenews.net/Greenwire/print/2010/07/27/8 ("So far, more than 300 federal lawsuits have been filed in 12 states. The plaintiffs range from shrimpers to condo owners to the owners of Ripley's Believe It or Not Museum, all claiming economic losses from the spill. There have also been wrongful death and injury suits filed by relatives of the 11 men who died when the Deepwater Horizon rig exploded April 20. Some BP PLC investors [have even sued] because of the dip in BP's stock."). In addition, Alabama filed suit against BP, Transocean, and Halliburton, "citing negligence and failure to adhere to industry safety standards," and seeking "economic and compensatory damages." Susanne Pagano, *Alabama Sues BP, Transocean, Others for Negligence, Safety Violations in Oil Spill*, 41 ENV'T REP. 1869, 1897 (2010); *see also* Alexander Cockburn, *Law Professor Warns of Federal Manslaughter Charges over BP Deepwater Oil Spill*, THE WEEK (Feb. 17, 2011, 7:29 AM) http://www.thefirstpost.co.uk/75220,news-comment,news-politics,bp-could-face-10bn-fines-and-jail-time-for-officials#ixzz1FZLTYsN2 (reporting that the federal government has announced it will file civil and criminal claims against the three principal companies involved in the spill and predicting that BP will face record criminal fines and could face federal manslaughter charges for the eleven deaths of rig crew members).

95. Campbell Robertson & Clifford Krauss, *Gulf Spill Is the Largest of its Kind, Scientists Say*, N.Y. TIMES, Aug. 2, 2010, at A14; *see also* Justin Gillis & John Collins Rudolf, *Oil Plume is Not Breaking Down Fast, Study Says*, N.Y. TIMES, Aug. 20, 2010, at A13 ("New research confirms the existence of a huge plume of dispersed oil deep in the Gulf of Mexico and suggests that it has not broken down rapidly, raising the possibility that it might pose a threat to wildlife for months or even years.").

B. The Nuclear Industry

The nuclear industry emerged almost at the same time as the offshore drilling industry, with the licensing of the first U.S. commercial nuclear power plant in 1957 in Beaver County, Pennsylvania.[96] For the past twenty years, nuclear energy has provided roughly twenty percent of baseload electrical power in the United States.[97] The primary reason for the steady nature of nuclear power's contribution to the electric power grid is the improved efficiency of nuclear power plants, which have provided increasingly reliable power during the past several decades.[98]

While *Deepwater Horizon* was far from the first offshore drilling accident of such magnitude, the accident at TMI-2 on April 28, 1979 was the first Class 9 accident the industry had experienced in

96. *See NRC: History*, U.S. NUCLEAR REG. COMMISSION, http://www.nrc.gov/about-nrc/emerg-preparedness/history.html (last visited Dec. 17, 2011) (reporting that the "Shippingport Atomic Power Station construction [was] completed at a cost of $72,500,000" in 1957). "The country's first large-scale civilian atomic power plant started generating electricity for commercial use on December 18, 1957. The plant, on the Ohio River twenty-five miles northwest of Pittsburgh, was built in thirty-two months. It [was] 'the world's first full-scale atomic electric power plant devoted exclusively to peacetime uses.'" *Id.*; *see also* Neal H. Lewis, *Interpreting the Oracle: Licensing Modifications, Economics, Safety, Politics, and the Future of Nuclear Power in the United States*, 16 ALB. L.J. SCI. & TECH. 27, 54 (2006) ("[T]he first civilian nuclear power plant came on-line in Shippingport, Pennsylvania [in 1957].").

97. Lewis, *supra* note 96, at 43 (noting that "[s]ince 1990, nuclear power has steadily maintained a 20% share of electricity production."). To accommodate the public's vacillating energy needs, electric utilities need access to power generating plants of varying capacity. *See* Fred Bosselman, *Ecological Advantages of Nuclear Power*, 15 N.Y.U. ENVTL. L.J. 1, 5–7 (2007). The majority of the time, during non-peak hours or seasons, this role is filled by "baseload" power plants, which operate continuously. *Id.*

98. Lewis, *supra* note 96, at 29 n.10 ("[T]he most important development in nuclear power during the 90's was increased efficiency. Nuclear power plant operation uptime increased almost every year from 60% in 1990 to 88% in 2000."). *See also* Nathan Hultman, Jonathan G. Koomey, & Daniel M. Kammen, *What History Can Teach Us About the Future Costs of U.S. Nuclear Power*, 41 ENVTL. SCI. & TECH., 2088, 2091 (2007), *available at* http://rael.berkeley.edu/sites/default/files/old-site-files/2007/HultmanetalNuclearViewpoint2007.pdf (attributing the improvement in the operating capacity of nuclear plants to "improvements in utilization rates and decreases in service down time"). Plant utilization rates increased after the NRC changed its rules to permit certain maintenance activities to be performed while a plant is operating. This shortened the time that a plant is out of service for refueling because much of the maintenance that could only be done on a plant during refueling can now be done at almost any time during operation. *See* Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, 56 Fed. Reg. 31306 (July 10, 1991) (amending the NRC's regulations); *see also* JOHN GAERTNER, KEN CANAVAN, & DOUG TRUE, ELECTRIC POWER RESEARCH INST., SAFETY AND OPERATIONAL BENEFITS OF RISK INFORMED INITIATIVES 6–7, 14 (2008), *available at* http://mydocs.epri.com/docs/CorporateDocuments/SectorPages/Portfolio/Nuclear/Safety_and_Operational_Benefits_1016308.pdf.

over 3,000 reactor-years of operation in the United States.[99] Since 1979, there have been forty-seven incidents at domestic reactors that required plants to shut down for more than a year because of safety concerns,[100] but none of these came close in severity to what happened at TMI-2.[101] While the number of nuclear accidents that have occurred domestically is only slightly lower than the number of recorded drilling accidents on the OCS,[102] the environmental impacts of the nuclear incidents have been substantially less severe.[103] Each incident, including TMI-2,[104] was contained with

99. A Class 9 accident is the most serious classification of nuclear power plant accidents. *See* A.M. METWALLY, *Nuclear Accidents and Associated Environmental Risk*, *in* PROCEEDINGS OF THE 2ND ENVIRONMENTAL PHYSICS CONFERENCE 223, 225 (2006), *available at* http://www.physicseqypt.org/epc06/epc632.pdf (describing the NRC accident classification system as providing guidelines for license applicants "to analyze a set of postulated severe accidents to show that the facility can be operated without undue risk to the health and safety of the public," while also attempting to establish a relationship between the "anticipated frequency of occurrence and potential radiological consequences"); *see also* Lewis, *supra* note 96, at 48 n.143 ("Three Mile Island and Chernobyl are 'the only major accidents to . . . occur[] in some 12,000 cumulative reactor-years of commercial operation in [thirty-two] countries.'").

100. *See* Bob Herbert, Op-Ed., *We're Not Ready*, N.Y. TIMES, July 20, 2010, at A23 (describing "[a]nother frightening accident" in 2002 at the Davis-Besse plant in Ohio, where a "hidden leak led to corrosion that caused a near-catastrophe. By the time the problem was discovered, only a thin layer of stainless steel was left to hold back the disaster."). More recently, radioactive tritium leaked from underground pipes at the Vermont Yankee nuclear power plant in Vernon, Vermont. *See* Peter Behr, *Experts Weigh Extending the Lives of Nuclear Power Plants for 80 Years*, CLIMATEWIRE (Sept. 20, 2010), http://www.eenews.net/climatewire/print/2010/09/20/1. Before that, in 2007, part of the plant's cooling tower collapsed. *Id.*

101. Since the partial core meltdown at TMI-2, there have been accidents of even greater significance at Chernobyl in the Ukraine and at the Fukushima Daiichi nuclear generating station in Japan; of the two accidents, only the Japanese one has had an impact on the safety of domestic nuclear reactors. *See* Hannah Northey, *NRC Rethinking Major Safety Requirements After Japan's Disaster*, GREENWIRE (June 27, 2011), http://www.eenews.net/Greenwire/print/2011/06/27/2 ("The Nuclear Regulatory Commission is reconsidering deep-seated safety assumptions after a massive earthquake and tsunami crippled a Japanese nuclear plant in March and revealed potential deficiencies in the United States' own safety guidelines."); *see also infra* note 413 (discussing NRC review of nuclear power plants' safety features after the Japanese accident).

102. *See generally supra* Part I.A (discussing the accident record of the offshore drilling industry).

103. *Safety of Nuclear Power Reactors*, WORLD NUCLEAR ASS'N (Sept. 30, 2011) http://www.world-nuclear.org/info/inf06.html.

104. *See* Laurence Stern et al., *Chapter 4: The Tough Fight to Confine the Damage*, WASH. POST, Apr. 8, 1979, at A1 [hereinafter Stern et al., *The Tough Fight to Confine the Damage*], *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/ch4.htm (quoting Metropolitan Edison's chief technical official as saying, "We didn't injure anybody with this accident; we didn't seriously contaminate anybody, and we certainly didn't kill anybody.").

minimal environmental and human exposure.[105]

1. The Three Mile Island Unit 2 Accident and Core Meltdown

> "The TMI accident scared the hell out of us . . . . [T]he possibility of a serious accident ceased to be a theoretical possibility, a highly unlikely event, and from that point on we began thinking much more seriously that accidents can really happen."[106]

The accident at TMI-2[107] in Middletown, Pennsylvania, occurred after the 880-megawatt plant had been operating at nearly full power (ninety-seven percent) for just over three months.[108] The accident started uneventfully, with a mechanical failure (for reasons that are still unknown) in the secondary, non-nuclear part of the plant.[109] This failure caused the pumps in that system to shut down,[110] which, in turn, shut down the main pumps responsible for

105. *See* WORLD NUCLEAR ASS'N, *supra* note 103 ("[T]he reactor was severely damaged but radiation was contained and there were no adverse health or environmental consequences."); *see also* KEMENY COMMISSION REPORT, *supra* note 15, at 12 (reporting that the NRC indicated the releases of radioactive steam were too small to cause any increase in detectable cancers); U.S. NUCLEAR REGULATORY COMM'N, BACKGROUNDER: THREE MILE ISLAND ACCIDENT 1 (2009) [hereinafter NRC BACKGROUNDER] *available at* http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.pdf (noting the average dose to the approximately 2 million people in the area was only about 1 millirem, well below the average exposure of 6 millirem for a chest x-ray). *But see* Joby Warrick, *Study Links Three Mile Island Radiation Releases to Higher Cancer Rates*, WASH. POST, Feb. 24, 1997, at A06, *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/study022497.htm (reporting that a 1997 University of North Carolina study found increases in lung cancer and leukemia near the plant, contradicting a 1990 Columbia University analysis using the same data that found no "clear connection between the accident and cancer rates among residents living near the plant").

106. JOSEPH V. REES, HOSTAGES OF EACH OTHER 27 (1994) (quoting a high level NRC official).

107. At the time of the accident, Unit 1 was shut down for routine refueling. J. SAMUEL WALKER, THREE MILE ISLAND: A NUCLEAR CRISIS IN HISTORICAL PERSPECTIVE 71 (2004).

108. *See* Laurence Stern et al., *Chapter 1: A Pump Failure and Claxon Alert*, WASH. POST, Apr. 8, 1979, at A1 [hereinafter Stern et al., *A Pump Failure and Claxon Alert*], *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/ch4.htm.
Although the plant began operations shortly before the end of 1978, in the early days of 1979 the plant repeatedly came off line to address various problems, such as leaks in the piping and pump system. *Id.*; *see also* Lewis, *supra* note 96, at 49; James Cook, *Inpo's Race Against Time*, FORBES, Feb. 24, 1986, at 54, 54, 57 (noting that Unit 2 was running at ninety-seven percent power and comparing it to the Davis-Besse nuclear plant, which had the same valve closure problem while it was running at nine percent power).

109. For a gripping chronological account of the accident and its aftermath, see generally WALKER, *supra* note 107.

110. The operators, who were trying to unclog some piping in the secondary water

bringing cooling water to the reactor.[111] This situation caused the reactor to "scram."[112] When the primary feedwater pump system failed, three backup auxiliary pumps were designed to come online automatically.[113] However, the control room operators had turned those pumps off because they had been coming online for no apparent reason; the operators did not, at the time, know that water was flowing out of the nuclear core, and they feared (erroneously) that the core was being flooded with too much water.[114] Having completely misdiagnosed the situation, the operators actually began to drain water from the reactor.[115] Regardless, even if the operators had not shut off the backup pumps, all three valves in that system had been closed for routine maintenance and the system would not have been able to pump any water to the reactor.[116]

Although the pumps were later activated manually, loss of coolant from the primary loop and the failure to activate the

circulation system, accidentally blocked the flow of cooling water to the reactor, which stopped heat removal. *Three Mile Island: The Inside Story—Five Hours in Which the Unthinkable Happened*, SMITHSONIAN NAT'L MUSEUM OF AM. HIST. http://americanhistory.si.edu/tmi/tmi03.htm (last visited Oct. 6, 2011) [hereinafter SMITHSONIAN, *Five Hours*].

111. NRC BACKGROUNDER, *supra* note 105, at 1.

112. When a reactor "scrams," control rods are dropped into the core to block nuclear fission from occurring or to slow the rate down. In the case of TMI-2, because the plant had been operating at nearly full capacity, the reactivity in the fuel rods continued to generate considerable heat even after the control rods were inserted, which caused the remaining water in the reactor to boil away and left the rods exposed. SMITHSONIAN, *Five Hours, supra* note 110.

113. *See* WALKER, *supra* note 107, at 76 ("About two minutes into the accident, the high-pressure injection pumps, a part of the ECCS, automatically activated in response to the loss of coolant from the core.").

114. NRC BACKGROUNDER, *supra* note 105, at 1 (noting that the control room operators relied on pressurizer water levels, which were high, because they did not know that steam pockets, created by bubbles of steam from the boiling reactor core, were forming, and there was no instrument in the control room reporting core water levels); *see* KEMENY COMMISSION REPORT, *supra* note 15, at 98 (explaining that steam bubbles forming in the reactor coolant system displaced reactor cooling water, which moved into the pressurizer and sent pressurizer levels higher, suggesting that the "the core was on its way to being uncovered," as more water was leaving the system than was being added to it); *see also id.* at 100 ("Steam bubbles formed by the rapidly over-heating rods forced cooling water away from the fuel rods."); SMITHSONIAN, *Five Hours*, supra note 110 (stating that the operators were trained to prevent an over-filling of the pressure vessel with water and explaining that the operators though this was happening because the boiling water in the core created the impression that it was filling with water).

115. KEMENY COMMISSION REPORT, *supra* note 15, at 94.

116. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 3; *cf.* REES, *supra* note 106, at 17 ("A good benchmark for power plant complexity is the number of valves it has; a typical nuclear reactor has 40,000—ten times the number in a coal fired plant.").

auxiliary cooling system caused pressure to mount in the pipes, triggering the automatic opening of what is known as a pilot operated relief valve (PORV).[117] The valve should have closed after the release of excess pressure, but a mechanical fault prevented this from happening.[118] The open valve allowed cooling water to escape from the primary system instead of being directed into the reactor core.[119] "Temperatures inside the reactor began to soar. Readings climbed 30 degrees in less than 3 seconds."[120] Even though the scramming of the reactor halted the chain reaction in the core, the system was still generating heat and temperatures continued to climb.[121]

Two minutes into the accident, the plant's emergency core cooling system (ECCS) activated automatically,[122] but an operator turned off one of the pumps and significantly "throttled back" on the operation of the other because he feared that the pressure vessel was filling with water.[123] The operator then compounded this error by shutting off the four reactor coolant pumps because they were vibrating badly from excessive amounts of steam, and he was afraid they would be damaged.[124] Thus, approximately two hours into the accident, after virtually all pumps carrying cooling water to

117. The function of the PORV is to blow off over-heated radioactive water within the pressure vessel. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 2.

118. NRC BACKGROUNDER, *supra* note 105, at 1.

119. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 2 (describing how the relief valve, which had automatically opened "to blow off superheated, radioactive water within the containment structure," failed to close, allowing pressurized steam "to continue pouring out of the reactor"); NRC BACKGROUNDER, *supra* note 105, at 1 (explaining that the relief valve failed to close, allowing cooling water to pour out of the "stuck-open valve" and causing "the core of the reactor to overheat").

120. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 3. Once temperature indicators in the control room reached 750 degrees, the control room machinery began printing question marks for the next eleven hours. *Id.* at 5; *see* WALKER, *supra* note 107, at 78 ("Later investigations estimated that in some parts of the core, the temperature reached four thousand degrees Fahrenheit or more.").

121. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 3.

122. WALKER, *supra* note 107, at 76 (noting, in addition, that the system "performed flawlessly"). An ECCS is a backup system that automatically starts and "uses existing plant equipment to ensure that cooling water covers the [reactor] core." KEMENY COMMISSION REPORT, *supra* note 15, at 89. The Kemeny Commission defined the ECCS as "[a] backup system designed to supply cooling water to the reactor core in a loss-of-coolant accident." *Id.* at 174.

123. *See id.* at 76–77 (explaining that the system was turned off because operators feared the pressurizer was "going solid," i.e. was filling with water, which would have interfered with the operators' ability to control pressure in the system).

124. *See id.* at 77.

the core had been shut off, no water was circulating to the reactor core, leaving it exposed.[125]

The intense heat in the core caused a reaction between the steam forming in the core and the Zircaloy nuclear fuel rod cladding, which destroyed the cladding and further damaged the fuel rods, releasing more radioactivity into the reactor coolant.[126] This process caused a small explosion due to the production of hydrogen gas.[127] Radioactive water quickly accumulated on the floor of the containment building, which activated sump pumps that moved the water out of the containment structure into tanks in the auxiliary building.[128] The activation of the sump pumps, together with the operator's deactivation of the ECCS pumps and the fact that three valves had been taken out of service for routine maintenance at the time of the accident, made the situation much worse; had these circumstances not all come to pass at the same time, the accident might have quickly been brought under control.[129]

Over three hours into the accident, a monitor in the containment building showed radiation at 8 rems per hour, which

125. *See* Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 5 (reporting that after "an operator turned off four cooling pumps, two at 1 hour 15 minutes and two more at 1 hour forty minutes into the accident . . . , the water level in the reactor vessel plunged again, uncovering the core and fuel rods for the first time . . . . The water level had dropped at least four feet below the top of the core, uncovering one-third of the fuel rods."); *see also* SMITHSONIAN, *Five Hours*, supra note 110 ("4:05-6:00 a.m. The water in the reactor boils away, leaving more and more of the reactor's fuel 'high and dry.'").

126. By the time the accident ended, over ninety percent of the cladding around the fuel rods had been destroyed. KEMENY COMMISSION REPORT, *supra* note 15, at 30; *see also* Mark P. Widoff, *The Accident at Three Mile Island*, 4 W. NEW ENG. L. REV. 223, 223 (1982) ("Fuel rods in reactor core unit 2 (TMI-2) melted because of coolant loss. The meltdown caused highly radioactive fission byproducts and uranium pellets to be released into the water coolant system and into the atmosphere.").

127. KEMENY COMMISSION REPORT, *supra* note 15, at 99. Though the NRC initially worried that an explosion within the reactor containment building might occur because of a large hydrogen bubble in the reactor pressure vessel dome, staff later concluded that the absence of oxygen in the vessel meant the bubble could neither burn nor explode. *See* NRC BACKGROUNDER, *supra* note 105, at 2. The effect of hydrogen bubbles in reactor containment vessels was dramatically illustrated by the explosions that partially destroyed two of the outer containment buildings at the Fukushima nuclear generating station in March 2011. *See* David Biello, *Partial Meltdown Led to Hydrogen Explosions at Fukushima Nuclear Power Plant*, SCIENTIFIC AMERICAN, Mar. 14, 2011, http://www.scientificamerican.com/article.cfm?id=partial-meltdowns-hydrogen-explosions-at-fukushima-nuclear-power-plant.

128. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at A1. Had water remained in the reactor vessel rather than being diverted to the auxiliary building in the form of steam, it might have provided some cooling function for the core. *Id.* at 5.

129. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 4.

an hour later caused the building's automatic isolation.[130] Subsequent inspections of the reactor pressure vessel showed that five feet, roughly half of the reactor core, had been destroyed, and around twenty tons of uranium had flowed to the bottom of the reactor pressure vessel.[131] This prompted an executive vice president of Metropolitan Edison's parent company, GPU Nuclear, to state that "molten fuel 'flowed like hot olive oil'" during the accident.[132] Fortunately, the pressure vessel did not fail, and the five inch steel floor underneath the reactor vessel maintained its integrity.[133] Thus, the damaged fuel with nearly all of the radioactive isotopes remained in the core,[134] sparing the residents of nearby Harrisburg and other surrounding communities from what otherwise would have been an environmental and public health disaster. Had the extent of the emergency been known at the time—that half of the core had melted onto the containment floor—the surrounding area might well have been immediately evacuated.[135]

TMI-2 is now decommissioned; its fuel has been removed and sent to a Department of Energy storage facility, along with debris from the reactor core, the reactor coolant system has been drained,

130. Radiation levels in the plant buildings were high enough to require a declaration of a general emergency, which did not occur until much later. SMITHSONIAN, *Five Hours*, *supra* note 110; *see also* Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 6 (reporting that control room alarms were set to go off when radiation in the containment area reached eight rems); KEMENY COMMISSION REPORT, *supra* note 15, at 101–02 ("[At] 7:20 a.m., a radiation dome monitor high in the containment building was reading 8 rems per hour . . . . [T]hose in the control room interpreted the monitor's alarm as meaning that the radiation present in the containment building at the time was about 800 rems per hour.").

131. SMITHSONIAN, *Five Hours*, *supra* note 110. The full extent of the core damage was not appreciated during and immediately after the accident. The NRC did not realize that almost one half of the fuel rods in the reactor had been destroyed until 1987, nor did they realize that molten fuel had pooled on the reactor vessel floor until a decade after the accident. *Three Mile Island: The Inside Story—Five Score Years of Nuclear Power*, SMITHSONIAN NAT'L MUSEUM OF AM. HIST., http://americanhistory.si.edu/tmi/tmi11.htm (last visited Oct. 2, 2011) [hereinafter SMITHSONIAN, *Five Score Years*]; *see* WALKER, *supra* note 107, at 229 (noting that approximately "70 percent of the core had been damaged," and fifty percent of the core had melted, causing Metropolitan Edison to abandon any thoughts it had of reopening Unit 2).

132. WALKER, *supra* note 107, at 229.

133. SMITHSONIAN, *Five Hours*, *supra* note 110; *see also* WALKER, *supra* note 107, at 231 (recounting the reasons why the pressure vessel did not fail).

134. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 29–31 (describing the fate of solid and gaseous radioactive isotopes).

135. WALKER, *supra* note 107, at 241 (stating that had the NRC realized the nuclear core had "melted," it would have recommended a "full-scale evacuation," which Governor Thornburgh would have ordered); *accord* SMITHSONIAN, *Five Hours*, *supra* note 110.

and the radioactive water has been decontaminated and evaporated.[136] In 1993, the operating license for Unit 2 was amended to a "possession only" license, which authorized long-term monitoring and storage at the facility.[137] The current owner of Unit 1, Exelon, is monitoring the site.[138]

The economic impact of the accident on Metropolitan Edison, the owner and operator of Three Mile Island Units 1 and 2, and on the nuclear power industry was devastating. In approximately two hours, conditions at Unit 2 turned what had been a billion-dollar asset for the company into a multibillion-dollar liability.[139] It cost more to clean up Unit 2 than to build it.[140] In the decades that followed the accident at TMI-2, sixty-five U.S. nuclear power plants were cancelled.[141] The NRC issued the last construction permit for

136. NRC BACKGROUNDER, *supra* note 105, at 4; *see also* WALKER, *supra* note 107, at 229–32 (describing Unit 2 cleanup, including the defueling operation).

137. *Industry*, DICKINSON C., http://www.threemileisland.org/industry.html (last visited Oct. 2, 2011). Unit 1 resumed operating in 1985 after the Supreme Court held the National Environmental Policy Act did not counsel against its restart. *See* Metropolitan Edison Co. v. People Against Nuclear Energy, 460 U.S. 766 (1983); SMITHSONIAN, *Five Hours*, *supra* note 110.

138. In 2001, FirstEnergy acquired Unit 2 from General Public Utilities Nuclear Corporation (GPU), an electric utility holding company consisting of three operating companies—Jersey Central Power & Light Co., Pennsylvania Electric Company, and Metropolitan Edison. *Industry*, *supra* note 137. The three operating companies owned Three Mile Island at the time of the accident, with Metropolitan Edison operating both TMI Units 1 and 2. *Id.* In 1982, operation of Units 1 and 2 was transferred from Metropolitan Edison to GPU to separate "the current actions of the company from those at the time of the accident." *Id.* In 1999, GPU sold Unit 1 to AmerGen Energy, a joint venture of PECO (later Exelon) and a British energy company. *Id.* FirstEnergy merged with GPU, which ended its existence as an electric utility holding company, leaving the three original operating components of GPU as subsidiaries of FirstEnergy. *Id.* FirstEnergy and Exelon plan to keep Unit 2 mothballed until Unit 1's license expires, at which point both plants will be permanently decommissioned. *See* NRC BACKGROUNDER, *supra* note 105, at 4. In 2009, Unit 1's operating license was extended from 2014 to 2034. *See* Stephen Heiser, *NRC Renews Operating License for Three Mile Island for an Additional 20 Years*, NUCLEAR STREET (Oct. 26, 2009, 8:55 AM), http://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2009/10/26/nrc-renews-operating-license-for-three-mile-island-nuclear-power-plant-for-an-additional-20-years-10261.aspx (noting that Unit 1's license extension was the fifty-fifth renewal by the NRC since the agency started renewing expired operating licenses); *see also NRC Approves 20 Year License Renewal for Three Mile Island*, PA ENERGY ALLIANCE (Apr. 19, 2011), http://paenergyalliance.com/nrc-approves-20-year-license-renewal-for-three-mile-island.

139. Herbert, *supra* note 100.

140. *Id.* It took nearly twelve years and cost approximately $973 million to clean up TMI-2. *The TMI-2 Cleanup: Challenging and Successful*, AM. NUCLEAR SOC'Y, http://www.ans.org/pi/resources/sptopics/tmi/cleanup.html (last visited Oct. 2, 2011).

141. *See Cancelled U.S. Commercial Nuclear Reactors*, DATA.GOV, http://explore.data.gov/Energy-and-Utilities/Cancelled-U-S-Commercial-Nuclear-Power-Reactors/fxtq-q53p (last

a commercial nuclear power plant the year before the accident; the last licensed plant began operation in 1996.[142]

Both the deepwater drilling and nuclear power industries are important contributors to this country's economic well-being. Regardless, their contributions are not without risks to individual workers and the environment in which they operate. This Part of the Article has shown that the risks of catastrophic accidents and their attendant human and environmental consequences are realized more often on offshore drilling rigs than at nuclear power plants. The next part of the Article discusses the remarkable similarities between the direct and indirect causes of the Macondo well blowout and the Three Mile Island partial core meltdown, despite the fact that they occurred in two quite different industries and over thirty years apart.

II. THE DIRECT AND INDIRECT CAUSES OF THE MACONDO WELL BLOWOUT AND THE THREE MILE ISLAND UNIT 2 CORE MELTDOWN

Unlike TMI-2, where a cascade of events emanating from a single mechanical failure can be isolated and examined post hoc, precisely what happened on the *Deepwater Horizon* drilling rig is unknown because the rig was partially destroyed and several people with critical knowledge of the accident died tragically. Despite the unknowns, the President's Oil Spill Commission identified the probable causes of the accident after an exhaustive six-month inquiry. Direct causes identified by the Commission include the many operator errors, discussed below, that occurred on the rig

visited Dec. 18, 2011) (click the "xls" file ready for download) (listing sixty-five cancelled reactors); *see also* Amanda Leiter, *The Perils of a Half-Built Bridge: Risk Perception, Shifting Majorities, and the Nuclear Power Debate*, 35 ECOLOGY L.Q. 31, 56 (2008) ("Since 1978 . . . no new plants have been ordered and more than 100 reactor contracts have been canceled."); Lewis, *supra* note 96, at 28 ("In the twenty years prior to 1990, one hundred licenses were issued to operate nuclear reactors. A license for a new nuclear facility in the United States has not been issued since the Watts Bar 1 facility was permitted in 1996 . . . . Over one hundred permits that were issued for the construction of nuclear facilities were withdrawn during the 70's and 80's."); Christopher C. Chandler, *Recent Developments in Licensing and Regulation at the Nuclear Regulatory Commission*, 58 ADMIN. L. REV. 485, 485 (2006) ("[M]ore than three decades have passed since a utility company placed an order for a new nuclear plant in the United States"); Widoff, *supra* note 126, at 225 ("[E]xpenditures for new plan[t]s and the unprecedented cost of borrowing money have discouraged new construction.").

142. The last commercial nuclear plant constructed in the U.S began operating in 1996, and the last nuclear power plant construction permit was issued in 1978. SMITHSONIAN, *Five Score Years*, *supra* note 131.

both before and during the accident,[143] which may have severely compromised the ability of available systems to prevent the accident and increased the risk of what otherwise might have been an avoidable, or at least containable, accident. When design deficiencies and failures of key components are added to the list of causes, the exact same story can be told about the accident at TMI-2.[144] In addition, in each case, pressure to keep operations on schedule contributed to a culture in which safety was less important than the economic bottom line and operating risks were under-appreciated by both management and the operating crews.[145] While regulatory failures also contributed to each accident, a detailed examination of those contributions is beyond the scope of this Article,[146] except insofar as they may be attributed to industry pressure.[147] For the purposes of this Article, it is sufficient to repeat

143. *See* COMMISSION REPORT, *supra* note 7, at vii ("The immediate causes of the Macondo well blowout can be traced to a series of identifiable mistakes made by BP, Halliburton, and Transocean that reveal such systematic failures in risk management that they place in doubt the safety culture of the entire industry."); *see also* Hoffman, *supra* note 18 at 2 (saying the accident "was a chain of important errors made by people in critical situations involving complex technological and organization systems." (quoting Robert Bea, an engineering professor at the University of California-Berkeley)).

144. Lewis, *supra* note 96, at 49 (describing the accident at TMI-2 as "the result of a combination of personnel error, design deficiencies, and component failures").

145. The President's Oil Spill Commission found a difference among the attitudes of offshore oil and gas companies toward safety depending on where their operations were located. The Commission noted that from 2004 to 2009, fatalities in U.S. waters were four times higher per person-hours worked than in European waters and concluded that this difference reinforced the conclusion that the problem was "not an inherent trait of the business itself, but rather depends on the differing cultures and regulatory systems under which members of the industry operate." COMMISSION REPORT, *supra* note 7, at 225.

146. This article does not examine the extent to which the principal regulatory agencies may have been captured by the oil and gas industry and the extent to which this lack of objectivity interfered with what otherwise might have been more zealous oversight. For those interested in that topic, see Emily Yehle, *Regulators Warned Oil Companies Before Offshore Inspections—IG*, E&ENEWS PM (Sept. 22, 2010), http://www.eenews.net/eenewspm/print/2010/09/22/2 (reporting that DOI Inspector General Reports "in recent years found that inspectors sometimes considered themselves part of the oil industry, accepted gifts from oil companies and attended parties with gas and oil officials."). For a discussion of how evisceration of the Council on Environmental Quality's "worst-case analysis" requirement during the 1980s contributed to regulatory agencies' failure to conceive of and disclose prospective effects of the catastrophic accident that overtook the *Deepwater Horizon* drilling rig, see Houck, *supra* note 49, at 11037–39. Houck also describes environmental reviews of the various phases of the lease approval process that led to the issuance of the exploration permit to drill the Macondo well as "a stack of babushka dolls, each couching a smaller one, each painted identically and saying the same misleading thing." *Id.* at 11037.

147. The President's Oil Spill Commission reported that the American Petroleum Institute (API) played an important role in resisting new regulations that would have made

the finding of the President's Oil Spill Commission that "the regulation of the offshore oil and gas industry in the U.S. Gulf of Mexico has not been robust, expertly staffed, well funded, competent or nimble,"[148] and that much the same could be said about the "robustness" of NRC oversight of nuclear power plants before TMI-2.[149]

offshore operations safer but also would have increased operational costs. *See* COMMISSION REPORT, *supra* note 7, at 225. The Commission also opined that the dependence of the MMS on API safety standards, which reflected the "'lowest common denominator'—in other words, a standard that almost all operators could readily achieve[,] . . . undermined the entire federal regulatory system." *Id.* *See also* Harold Meyerson, *The Many Sins of Deregulation*, WASH. POST, Aug. 26, 2010, at A13 ("So great was pressure to deregulate business that under the Clinton Administration, the MMS embraced 'performance-based regulation,' by which the companies themselves largely set the standards they would labor under."); Yehle, *supra* note 146 (recounting how one supervisor directed an inspector not to report a noncompliance incident on an Exxon Mobil platform, dismissing the incident as "a misunderstanding," and reporting that problems with the platform still remained as of September 2010, despite several noncompliance incidents); Zygmunt J.B. Plater, *Learning from Disasters: Twenty-One Years After the* Exxon Valdez *Oil Spill, Will Reactions to the* Deepwater Horizon *Blowout Finally Address the Systemic Flaws Revealed in Alaska*, 40 ENVTL. L. REP. 11041, 11042 (2010) (stating that the commission convened to examine the operational and institutional failures leading up to the *Exxon Valdez* incident "noted multiple areas in the 'mega-systems' of extracting and transporting oil in which the official players, both governmental and corporate, were enmeshed in a culture of complacency, collusion, and neglect.").

148. Staff Working Paper No. 21, *supra* note 6 at 1. The Commission staff also attributed the higher offshore fatality rate of U.S. oil and gas workers to the failure of the Department of the Interior to "embrace a risk-based oversight approach." *Id.*

149. One author noted that the "pro-development and anti-regulation" message the Atomic Energy Commission (AEC) received from the President and Congress led it to "ignore[] the industry's institutional arrangements for managing and operating nuclear power plants—that is, until TMI." *See* REES, *supra* note 106, at 31–32. In fact, before TMI-2, a "flood of license applications in the late 1960s and early 1970s" and the "dramatically increased size of the individual plants" overwhelmed the agency and caused long delays in licensing. WALKER, *supra* note 107, at 41. Nuclear power critics called the licensing process "a charade," designed to ensure the agency's goal of "licensing and construct[ing] . . . nuclear power plants as expeditiously as possible." *Id.* at 43 (quoting STEVEN EBBIN & RAPHAEL KASPER, CITIZEN GROUPS AND THE NUCLEAR POWER CONTROVERSY: USES OF SCIENTIFIC AND TECHNOLOGICAL INFORMATION 31 (1974)).

A. Direct Causes of the Accidents[150]

Many factors contributed to the accidents on the *Deepwater Horizon* drilling rig and in the control room at TMI-2. Among these causes were technical failures in key components at both facilities, the manufacturers' failure to share critical information about these problems with facility operators, operator errors that occurred both before and during the accident, poor communication between critical operating staff and management, and inadequate emergency response training.

1. Technical Failures

Both the drilling rig and the nuclear power plant experienced major technical problems prior to the *Deepwater Horizon* and TMI-2 accidents. A September 2009 audit showed that Transocean, the owner and operator of the *Deepwater Horizon* rig, had allowed a backlog of 390 maintenance jobs to accrue.[151] One outstanding job at the time of the accident included the repair of a leak that had occurred several weeks prior in the control pod of the blowout preventer (BOP),[152] a piece of equipment that played a critical role in the accident.[153] In violation of federal regulations, Transocean

150. On February 17, 2011, the Commission's Chief Counsel released his final report on the causes of the accident, which goes into much greater detail than the January 11, 2011, Commission Report, and lays most of the blame for the accident on BP. *See* Steven Mufson, *Federal Report Lays Bulk of Fault for Gulf Spill on BP*, WASH. POST, Feb. 18, 2011, at A18 (highlighting some of the findings of the report). A copy of the Chief Counsel's final report can be accessed on the Commission's website, www.oilspillcommission.gov. In the foreword to the report, the Commission's co-chairs, former EPA Administrator William Reilly and former Senator Bob Graham, state that "[i]n clear, precise, and unflinching detail, this Report lays out the confusion, lack of communication, disorganization, and inattention to crucial safety issues and test results that led to the deaths of 11 men and the largest offshore oil spill in our nation's history." CHIEF COUNSEL'S REPORT, *supra* note 65, at ix.

151. Achenbach & Hilzenrath, *supra* note 61. This audit found that the maintenance that had not been performed "requir[ed] more than 3,500 hours of work" and "referred to the amount of deferred work as 'excessive.'" Ian Urbina, *Workers on Doomed Rig Voiced Concern About Safety*, N.Y. TIMES, July 22, 2010, at A1.

152. Achenbach & Hilzenrath, *supra* note 61. The blowout preventer is "a five-story tower of valves atop the well bore that can, in principle, lock down and shut off a runaway well." Hoffman, *supra* note 18. One of the blowout preventer's pipe rams, which clamps around the drill pipe and can block the upward migration of methane and fluids, had been exchanged for an inoperable test version; further, one of the system's control pods, which activates a shear ram that cuts through the drill pipe and shuts down the well, had a dead battery. *Id.*

153. The Chief Counsel's final report, however, absolved defects in the blowout preventer as a "root cause" of the blowout, as the rig crew only activated the equipment "at best"

did not shut down operations on the rig when the drilling crew discovered the leak.[154] Moreover, the BOP was significantly overdue for an industry required inspection,[155] and other key components, such as BOP rams and valves that malfunctioned during the accident, were ten years past their inspection due dates.[156] In fact, at nine years old, the drilling rig had never been in dry dock for repairs.[157] At the time of the accident, there were at least twenty-six components and systems on the rig that were in "'bad' or 'poor' condition,"[158] including "mechanical problems with the rig's ballast system . . . that could directly affect the stability of the ship."[159] The rig also had leaking door seals, poor control panels, and a diaphragm on a major pump that needed to be replaced.[160] The evidence collected by the Oil Spill Commission

moments before the blowout, and hydrocarbons were well past the blowout preventer and proceeding rapidly towards the rig platform at that time. Even if the system had functioned "flawlessly, the rig would have exploded and 11 men would have died." CHIEF COUNSEL'S REPORT, *supra* note 65, at 198; *see also Gaskets May Have Blown Out on Blowout Preventer*, GREENWIRE (Feb. 25, 2011), http://www.eenews.net/Greenwire/print/2011/02/25/9 (reporting that shear rams cut through and closed the riser, but the increased velocity of crude coming up the pipe at that point may have destroyed the equipment's gaskets).

154. Hoffman, *supra* note 18. The drilling crew notified BP's home office in Houston, which neither suspended operations on the rig until the leak could be repaired nor notified MMS of the problem. *Id.*

155. Katie Howell, *BP Should Have Shut Down Doomed Rig Weeks Before Explosion, Regulator Says*, GREENWIRE (July 20, 2010), http://www.eenews.net/Greenwire/2010/07/20/5 (noting the blowout preventer was "past due on a three- to five-year inspection required by the manufacturer and the American Petroleum Institute."). According to an MMS study, blowout preventers had experienced 117 failures over a two-year period on the OCS at depths from 1,300 to 6,560 feet. *See* Houck, *supra* note 49, at 11035 (noting that 138 recorded failures in waters off of Albania, Brazil, Italy, and Norway did "little" to inspire confidence).

156. *See* Urbina, *supra* note 151, at A1 (noting that a Transocean report found that "many key components—including the blowout preventer rams and failsafe valves—had not been fully inspected since 2000, even though guidelines require inspection of the preventer every three to five years"); *see also* COMMISSION REPORT, *supra* note 7, at 114–15 (speculating that the failure of the BOP's emergency disconnect system, which should have closed the blind shear ram and severed the drill pipe, may have resulted from poor maintenance of the system).

157. Urbina, *supra* note 151, at A1 (quoting one rig worker as saying, "At nine years old, Deepwater Horizon has never been in dry dock . . . . We can only work around so much.").

158. *Id.*

159. *Id.*

160. *Id.* ("While the equipment report says the device's control panels were in fair condition, it also cites a range of problems, including a leaking door seal, a diaphragm on the purge air pump needing replacement and several error-response messages. The device's annulars, which are large valves used to control wellbore fluids, also encountered 'extraordinary difficulties' surrounding their maintenance . . . ." (quoting a Transocean equipment report)). The Transocean report also noted "the rig's malfunctioning pressure

regarding the technical and mechanical problems that led to the accident indicates that it was not "a single unlucky or freak event, but rather an engineered catastrophe."[161]

TMI-2 had a similar technically problematic start to its life, raising serious questions as to whether the plant was brought to full power before the kinks had been worked out. From the time the unit went online to the start of the accident, Unit 2 had been shut down for seventy-one percent of the time (195 out of 274 days).[162] According to the Kemeny Commission, this malfunction rate was significantly worse than the usual forty percent rate experienced by reactors during their start-up phase.[163] Many of the problems plant operators found during the reactor's first year of operation were similar to those that occurred during the accident.[164] By comparison, Unit 1 had an exemplary safety record.[165]

2. Information Failures

Apart from the technical problems that plagued both facilities, the companies responsible for key components of the Macondo well and Unit 2 failed to share critical information about the integrity of those components with their owners and operators. For example, critical tests measuring the stability of the cement used to plug the Macondo well conducted days before the accident as part of normal temporary well abandonment procedures[166] showed

gauge and leaking parts and faulted the decision by workers to use a type of sealant 'proven to be a major cause of pump bearing failure.'" *Id.*

161. Achenbach & Hilzenrath, *supra* note 61 ("The calamity, the evidence now suggests, was not an accident in the sense of a single unlucky or freak event, but rather an engineered catastrophe—one that followed naturally from decisions of BP managers and other oil company workers on the now-sunken rig.").

162. Stern et al., *A Watchful Eye on the Black Ink*, WASH. POST, Apr. 9, 1979, at A1 [hereinafter Stern et al., *Black Ink*].

163. *Id.* at A2; *see also* KEMENY COMMISSION REPORT, *supra* note 15, at 43 (reporting on repeated problems with the condensate polishers over the eighteen months preceding the accident, which were not corrected and "probably initiated the March 28 sequence of events").

164. *See* Stern et al., *Black Ink*, *supra* note 162, at A1 (noting that Unit 2 was shut down for two weeks in January because of cooling system problems).

165. *Three Mile Island: The Inside Story*, NAT'L MUSEUM OF AM. HIST., BEHRING CENTER, http://americanhistory.si.edu/tmi/tmi03.htm (last visited Oct. 4, 2011). Unit 1, which continued to operate after the accident at Unit 2, set a world record in 2003 for "the continuous operation of a pressurized water reactor." Lewis, *supra* note 96, at 50.

166. *See* CHIEF COUNSEL'S REPORT, *supra* note 65, at 128 (describing the "basic procedures" followed during temporary well abandonment, including conducting negative pressure tests).

anomalies, indicating that the cement was unstable.[167] This information was not shared by Halliburton, who made the cement, with BP or Transocean.[168] Nor did Transocean share information with BP about "a similar near miss" blowout incident during temporary well abandonment procedures on one of its North Sea drilling rigs that occurred a mere four months prior to the Macondo well blowout.[169]

The same failure to share critical information happened at TMI-2. For example, a relief valve, designed to blow off over-heated radioactive water within the Unit 2 pressure vessel that failed to close during the accident because of a mechanical fault, had failed on nine previous occasions in reactors "of similar design."[170] Babcock & Wilcox, the manufacturer of the Unit 2 reactor, did not notify other operators of their reactors, including Metropolitan Edison, about the problem.[171] Indeed, almost the entire chain of events that occurred at TMI-2 had occurred in 1977 at a Babcock & Wilcox reactor at Toledo Edison's Davis-Besse plant, but, in that case, operators identified and corrected the problem quickly.[172] Had any of this information been available to the Unit 2 control room operators, "a simple breakdown would not have escalated into a disastrous meltdown."[173]

3. Operation Failures

In addition to the technical and information failures that

167. COMMISSION REPORT, *supra* note 7, at 117–18.

168. *Id.*; *see also* CHIEF COUNSEL'S REPORT, *supra* note 65, at 124 (indicating that while BP engineers were aware that the cement job on the Macondo well would be difficult and that Halliburton's engineer was not doing "quality work," BP did not review the cement design (quoting an internal BP document)).

169. CHIEF COUNSEL'S REPORT, *supra* note 65, at 230.

170. REES, *supra* note 106, at 22.

171. Cook, *supra* note 108, at 54 (explaining that the NRC and Babcock & Wilcox, the manufacturer of the Unit 2 and Davis-Besse reactors, had investigated the Davis-Besse valve failure, but had not "alerted utilities with similar plants to take preventative measures").

172. REES, *supra* note 106, at 22 (noting that researchers at the Tennessee Valley Authority and the NRC had "postulated and analyzed" the entire sequence of events that later happened at TMI-2).

173. *Id.* at 22–23 (noting also that prior to TMI-2 there was no regulatory requirement or industry procedure for distributing information about "abnormal events" to other utilities, or for analyzing their safety significance or applicability to other plants); Senate Three Mile Island Hearing, *supra* note 16 (statement of Peter B. Lyons, Comm'r, Nuclear Regulatory Comm'n) (saying if information from 1977 Davis-Besse plant accident had been shared with Metropolitan Edison and if Unit 2 operators "had duplicated the operator response at Davis-Besse, the nation would not have experienced TMI").

occurred at both facilities, the drilling rig and control room operators made bad decisions that effectively turned each accident into a disaster.[174] These errors made the mechanical and technical problems of both structures significantly worse,[175] as did the initial failure of facility operators to recognize what was happening. As illustrated below, these failures can be linked both to inadequate training and to an ambiguous, confusing flow of important information during each accident, which the operators either ignored or misinterpreted. Tragically, if any one of the errors that occurred at either facility had been corrected at the time they occurred, the accidents might have been averted.[176]

Each crew ignored early warning signals and made questionable decisions immediately prior to or in the early stages of each accident. For example, an alarm system on the *Deepwater Horizon* drilling rig designed to alert platform workers and prevent

174. One commentator noted, "[T]he Horizon disaster resulted from many human errors and technical failings in a risk-taking corporation that operated in an industry with ineffective regulatory oversight." Hoffman, *supra* note 18. The same commentator criticized BP's decisions to include the use of single string from wellhead to well bottom instead of hanging a liner from the last section of casing installed and cemented, to employ six centralizers instead of the recommended twenty-one centralizers, and not to run a cement bond log, an acoustic test measuring the success of the cement's bonding with the casing and surrounding rock formation. *Id.* at 7.

175. William R. Freudenburg suggests that "'[h]uman error' is a value-laden term . . . that has often been used to describe situations that might more appropriately be blamed on mismatches between people and machinery." William R. Freudenburg, *Nothing Recedes Like Success? Risk Analysis and the Organizational Amplification of Risks*, 3 RISK: ISSUES IN HEALTH & SAFETY 5, 6 (1992). Human errors "are commonly seen as the 'fault' of the individual workers involved, rather than of any larger organizational systems . . . [,] tend by their nature to be preventable and/or correctable. . . [,] [and] are often identified by official investigations that are conducted after accidents and technological disasters as having been key, underlying, causal factors." *Id.* at 6–7. The problems Freudenburg attributes to individual workers range from "insufficient levels of capability (due to limited intelligence, inadequate training, and absence of necessary talents, etc.) to . . . low levels of motivation (laziness, sloppiness, use of alcohol/drugs, etc.)." *Id.* at 6. These are "'[s]tochastic' human factors," or "'stochastically predictable' problems," which can be triggered by "fatigue, negative responses to stress, occasional errors in judgments, or prosaically predictable 'bad days.'" *Id.* at 7. Engineered responses to these problems may make matters worse by making the work more routine and boring. *Id.* at 8.

176. *See* COMMISSION REPORT, *supra* note 7, at 120–21 ("The drilling crew and other individuals on the rig also missed critical signs that a kick was occurring. The crew could have prevented the blowout—or at least significantly reduced its impact—if they had reacted in a timely and appropriate manner . . . . The crew should have diverted the flow overboard when mud started spewing from the rig floor. While that ultimately may not have prevented an explosion, diverting overboard would have reduced the risk of ignition of the rising gas."); *see also* WALKER, *supra* note 107, at 77 ("As a consequence of mechanical failures and operator errors, what began as a series of minor malfunctions escalated into a major crisis.").

combustible gases from reaching potential sources of ignition had been disabled because it had gone off frequently and kept the drilling crew from getting needed sleep.[177] Similarly, in the case of TMI-2, the control room operators had grown used to ignoring alarms because they went off all the time.[178] Further, the drilling crew on the *Deepwater Horizon* rig made an inexplicable and unexpected decision in light of prevailing practices to replace heavy but expensive drilling muds with ocean water,[179] and placed the well plug lower in the pipe than was commonly done, precipitating the flow of gas up the pipe and reducing the ability of the crew to contain it.[180] The control room operators at TMI-2 made what appeared in hindsight to be an equally inexplicable decision to turn off critical pumps that had automatically started in the very early phases of the accident and would have kept the reactor core flooded with water, preventing a core meltdown.[181] Moreover, in violation of NRC rules, all three valves on that system

177. David S. Hilzenrath, *Technician: Deepwater Horizon Warning System Disabled*, WASH. POST, July 23, 2010, http://www.washingtonpost.com/wp-dyn/content/article/2010/07/23/AR2010072302515.html?nav=emailpage.

178. *See* Larry Foulke, *Thirty Years After TMI: Five Lessons Learned*, BULL. OF ATOMIC SCIENTISTS (Mar. 23, 2009), http://www.thebulletin.org/print/web-edition/features/thirty-years-after-tmi-five-lessons-learned (quoting a control room operator as saying, "I would have liked to have thrown away the alarm panel. It wasn't giving us any useful information," and also noting that "[t]he operators were overwhelmed and unnerved from the 'alarm avalanche.'").

179. Achenbach & Hilzenrath, *supra* note 61 (citing additional examples of operational failure, including BP managers' decision "to skip a typically routine, and time-consuming, 'cement bond log' test that could have detected fissures in the cementing of the well," to not "use the recommended 21 'centralizers' to position the well prior to the cement job, deploying just six instead," and to use "the cheaper of two well designs, one with fewer barriers to rising gas but costing $7 to $10 million less"). Drilling muds play a critical role in the exploration phase of offshore development: they stop oil from rushing up the pipe and must remain in place even "as high tech equipment maneuvers in and out of the hole, as steel tubing is installed to extract the oil, as the many leakage points are sealed up . . . ." Benjamin Ross, *Danger Culture/Safety Culture*, DISSENT, Winter 2011, at 7 (noting also that this maneuvering is "done by remote control, using communications lines, power cables, and equipment jammed together in a mud-filled tube miles long and inches wide.").

180. COMMISSION REPORT, *supra* note 7, at 103 (discussing the fact that BP set the cement plug deeper than permitted without approval from MMS, and "deeper than usual."). The Commission also cited BP's decisions to set the plug lower than usual in the riser and to displace the drilling muds before setting the plug as factors that both "substantially increased the risk of a blowout." *Id.* at 120.

181. *See* WALKER, *supra* note 107, at 76–77 ("About four and a half minutes into the accident, . . . the shift foreman[] ordered that one of the high-pressure injection pumps be shut down and the other sharply throttled back.").

had been closed for routine maintenance,[182] so that even if the pumps had not been turned off, they could not have pumped any water to the reactor. These decisions guaranteed that there would be a core meltdown.[183]

Additionally, there were several errors that occurred during the course of each accident that prevented the drilling rig and power plant crews from avoiding or, at least, containing each catastrophe.[184] Each crew ignored or misinterpreted critical technical information that should have informed them that an abnormal situation was developing.[185] In the case of *Deepwater Horizon*, negative pressure tests used to evaluate the primary integrity of the well repeatedly showed that hydrocarbons were flowing into the well when they should not have been.[186] The drilling crew, refusing to believe what they were seeing, kept re-running the tests and coming up with various explanations for the anomalous readings until they convinced themselves that their assumption (that oil could not be flowing in the well) was

182. Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 3.

183. *See* WALKER, *supra* note 107, at 77 (stating that "[i]n the first one hundred minutes or so of the accident," if the PORV had been closed, the ECCS had been allowed "to perform as designed," or reactor coolant pumps had been kept running, "the core would have remained covered and the emergency would have ended with minimal effects").

184. In both cases, events occurred very rapidly with minimal time to intercept and correct the errors that led to the accidents. *See* REES, *supra* note 106, at 17 (noting that things can happen very rapidly when a malfunction occurs, as it did in Unit 2 when a critical valve stuck in the open position, which left managers with very little time to correct the malfunction). *See also* COMMISSION REPORT, *supra* note 7, at 122 (noting that the drill rig crew did not have much time to act, as the explosion dooming the rig happened approximately six to eight minutes after mud first began to spew out of the well onto the rig floor).

185. *See* Hoffman, *supra* note 18. Robert Bea, a professor at the University of California-Berkeley, calls this behavior the "normalization of deviance," which happens when a company has become so "used to operating at the margins of safety" that it "regard[s] red flags as normal . . . ." *Id.* Red flags "cropped up repeatedly on the Macondo well, with the frequency accelerating in the four days before the blowout." *Id.*

186. COMMISSION REPORT, *supra* note 7, at 119 (the negative pressure tests "showed repeatedly that . . . hydrocarbons[] were flowing into the well. The failure to properly conduct and interpret the negative-pressure test was a major contributing factor to the blowout."). One possible reason for these failures was that neither BP nor Transocean had any internal procedures for running or interpreting negative pressure tests and had not formally trained their personnel in how to perform them. *Id.* In addition, BP's abandonment procedures called for the running of two negative-pressure tests; instead, BP dropped one of these tests, the second of which, had it been conducted "at a different depth[,] might have given the rig crew another opportunity to recognize [missed] . . . signals." CHIEF COUNSEL'S REPORT, *supra* note 65, at 134–35.

correct.[187] The crew missed telltale signs of an impending blowout—for example, signs that a spike in pressure had occurred when pumps were turned off as part of the normal well abandonment process.[188] The crew also inexplicably did not do a flow check when they observed that there was an anomalous pressure reading between the drill pipe and so-called "kill line," which would have led to an immediate shut down of the well.[189]

Similarly, Unit 2 control room operators did not believe the incredibly high temperature and pressure readings from the PORV line and the containment building that they were seeing on their monitors.[190] They thought the monitors were malfunctioning, especially when they began to display a series of question marks for the ensuing eleven hours.[191] The operators ignored other indications that a serious accident was occurring, including rising levels of radiation in the reactor buildings.[192] Further, key monitors were not visible to the operators trying to control the accident,[193]

187. *See* COMMISSION REPORT, *supra* note 7, at 6. The Commission referred to the Transocean crew as having "started from the assumption that the well could not be flowing, and kept running tests and coming up with various explanations until they had convinced themselves their assumption was correct." *Id.* at 119.

188. *See id.* at 120–21; *see also* CHIEF COUNSEL'S REPORT, *supra* note 65, at 180–81 (commenting that while the Transocean rig crew noted an anomaly less than fifteen minutes before the blowout started and shut the well down to investigate, the existence of several anomalies that "should have 'caused alarm'" caused none).

189. COMMISSION REPORT, *supra* note 7, at 121.

190. Laurence Stern et al., '*Too Little Information Too Late*,' WASH. POST, http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/app2.htm (last visited Jan. 2, 2012) [hereinafter Stern et al., '*Too Little Information Too Late*'] (quoting the NRC's System Safety Director as reporting that it took the NRC "until midnight last night [March 29] to convince anybody that those goddamn temperature measurements meant something," because the people faced with a partial core meltdown simply did not "believe[] the instrumentation as they went along").

191. *See* Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108; *see also* Foulke, *supra* note 178, at 3 ("[N]ecessary information wasn't readily available in a convenient and understandable form").

192. SMITHSONIAN, *Five Hours*, *supra* note 110.

193. Senate Three Mile Island Hearings, *supra* note 16 (statement of Peter B. Lyons, Comm'r, Nuclear Regulatory Comm'n) (reporting that a conversation with a control room operator during the accident made him no longer think that "a simple explanation of operator error largely covered the event," but rather that "the design of the control room and the instrumentation available to him dramatically limited his ability to comprehend the situation"). In the case of TMI-2, ambiguous and confusing control room indicators, such as a valve indicator light, designed to go dark and which did go dark during the accident when the PORV was closed, did not actually reflect the position of the valve. WALKER, *supra* note 107, at 73–74. Instead, all that it reported was that power was no longer flowing to the operating mechanism. *Id.* at 74. This design defect delayed the proper response by the control room operators. *See id.* A pressure indicator downstream of the PORV could have

instruments in the control room did not show that a critical valve was open, and there were no instruments to inform the operators of the coolant level within the core.[194]

Finally, each crew also overlooked critical safety systems that might have prevented, or at least minimized, each accident. Key members of the crew on the *Deepwater Horizon* rig failed to use safety equipment that could have diverted the plume of drilling muds and gas coming up the pipe overboard or closed the well, in part because they had not been adequately trained in the equipment's use.[195] While these actions might not have prevented the explosion that led to the rig's destruction, they "could have given the crew more time and perhaps limited the impact of the explosion."[196] Similarly, Unit 2 operators disabled the very system that could have prevented the core meltdown—the ECCS—perhaps because they too had never been drilled in how to respond to an accident of this dimension.[197]

4. Communication Failures

The bad decisions made by key personnel were intensified by poor to non-existent communication between critical staff preceding and during the course of each accident. In the case of *Deepwater Horizon*, some have suggested that the lack of pre-accident

told the operators the valve was stuck open, but it was located behind seven foot high instrument panels, requiring the operators to walk around the panels to determine conditions in the reactor-coolant drain tank, which they were not trained to do because the pressure indicator was not one of the indicators they were to use after an incident. *Id.*

194. *See* NRC BACKGROUNDER, *supra* note 105, at 1. It was not until two hours after the accident started that operators realized the PORV could be stuck open and not until a full hour after that before it dawned on them that the open valve meant the reactor could be running out of water. *See* SMITHSONIAN, *Five Hours*, *supra* note 110. Although feedwater pumps were turned on again, the cooling water could not penetrate the molten mass of collapsed and melted fuel rods, so the internal heating process continued. *See id.*

195. *See* COMMISSION REPORT, *supra* note 7, at 122 ("[T]he rig crew had not been trained adequately how to respond to such an emergency situation.").

196. *Id.* at 121.

197. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 10. ("[T]he training of TMI operators was greatly deficient. While training may have been adequate for the operation of a plant under normal circumstances, insufficient attention was paid to possible serious accidents. And the depth of understanding, even of senior reactor operators, left them unprepared to deal with something as confusing as the circumstances in which they found themselves."); *see also* Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 4 (concluding that the decision to shut down the emergency core cooling system together with the earlier decision to take three critical valves out of service simultaneously and divert radioactive water from the containment building to the auxiliary building made the accident much worse and assured that operators could not reverse or, at minimum, control it).

coordination between Transocean and BP, both on the rig and onshore, contributed to the blowout.[198] The onboard drilling rig crew and offshore management in Houston did not communicate when the well's behavior became irregular.[199] When the unthinkable happened and drilling muds began to spill onto the drilling deck floor, post-accident reports indicate that there was chaos, with no one (on or off the rig) clearly in charge of coordinating a response to the accident.[200]

Similarly, as the accident at TMI-2 unfolded, no dedicated open lines of communication existed between the nuclear plant and either state or county offices of emergency preparedness, let alone with the NRC in Bethesda, Maryland.[201] In the early phases of the accident, there was minimal communication between Unit 2's control room operators and company management;[202] it was not until many hours later, well after the core had gone critical, that anyone talked to the NRC.[203] The nearest town was not told of what

198. The Chief Counsel's Report noted that "[i]nadequate communication and excessive compartmentalization of information contributed to the Macondo blowout." *See* CHIEF COUNSEL'S REPORT, *supra* note 65, at 227. It cited cementing and temporary abandonment processes as key examples of the failure of BP's onshore engineers to communicate risks to BP workers and contract personnel on the rig. *Id.* at 228.

199. *See id.* at 229–30 (reporting that a BP vice president who was on the rig before the blowout and who had questioned an email he had received attributing negative pressure tests to "a bladder effect" was not consulted, and neither was any shore-based engineer at the company's headquarters in Houston).

200. Hoffman, *supra* note 18. For a riveting account of the accident, including the pandemonium that occurred on the rig deck after it caught fire, see COMMISSION REPORT, *supra* note 7, ch. 1.

201. The NRC "response center had no dedicated lines from the plant or a data transmission system to speed the flow of information." WALKER, *supra* note 107, at 92. The NRC Director of Regulation complained about "frightfully inadequate" site communications, prompting "installation of dedicated [telephone] lines between the site, the White House, the NRC, and the governor's office," including a red phone connecting him directly to White House switchboard. *Id.* at 146–47. For a general discussion of the problems, see *id.* chs. 4–5.

202. *See* REES, *supra* note 106, at 17 (explaining that company managers' non-involvement in daily nuclear power plant operations was modus operandi before TMI-2; after the accident, it was identified as "one of the industry's 'foremost safety and reliability issues'" (quoting Institute of Nuclear Power Operations)). This pattern of nuclear utility executives not getting their hands "dirty" was the model followed by the utility industry when they were operating fossil fired plants, where things were "pretty much left . . . to the plant manager to run everything." *Id.* at 18 (quoting the chief executive officer of a nuclear utility).

203. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 101 (reporting that NRC Region I did not learn of the accident until nearly four hours after it started, at which point plant management had elevated what had been declared a "site emergency" to a "general emergency" and had evacuated the auxiliary building).

was happening until days later.[204] Additionally, the company did not tell state or federal officials that on the first day of the accident there may have been a small hydrogen explosion in the containment building.[205] One of the NRC Commissioners later revealed that it took the NRC over five weeks to learn that plant operators had measured fuel temperatures near the melting point, and they did not learn until years later, when the reactor vessel was opened in July 1984, that nearly one-half of the fuel had already melted when the company reported the accident to the NRC.[206] As the Director of Regulation, Harold Denton, reported to a meeting of the Commissioners:

> It just seems like we are always second, third hand; [sic] second guessing them. We almost ought to consider the [NRC] chairman talking to the owner of the shop up there and get somebody from the company who is going to inform us about these things in advance if he can, and then what he is doing about it if he can't. We seem not to have that contact.[207]

This reluctance to share information made the response of the federal and state governments to the emergency more difficult and attenuated.

Metropolitan Edison was also less than forthcoming with the

204. Laurence Stern et al., *How the Crisis Was Managed,* WASH. POST, Apr. 9, 1979, at Al [hereinafter Stern et al., *How the Crisis Was Managed*], *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/ch2.htm. The mayor of Harrisburg learned of the accident after receiving a call from a Boston radio station asking for his response to the nuclear emergency. KEMENY COMMISSION REPORT, *supra* note 15, at 104.

205. Laurence Stern et al., *Danger of Day 3—Nuclear Shower If Core Melts,* WASH. POST Apr. 9, 1979, at Al [hereinafter Stern et al., *Danger of Day 3*], *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/ch6.htm; *see also* Stern et al., '*Too Little Information Too Late,*' *supra* note 190 (reporting that the Systems Safety Director said to the Commissioners: "[W]e just learned—I don't know—three hours ago, that on the afternoon of the first day, some 10 hours into the transient, there was a 28 pound containment pressure spike. We are guessing that there may have been a hydrogen explosion. They, for some reason, never reported it here until this morning. That would have given us a clue hours ago . . . .").

206. *See* Victor Gilinsky, *Behind the Scenes of Three Mile Island,* BULL. OF ATOMIC SCIENTISTS (Mar. 23, 2009), http://thebulletin.org/web-edition/features/behind-the-scenes-of-three-mile-island.

207. Stern et al., '*Too Little Information Too Late,*' *supra* note 190. Stern et al. also quoted Commissioner Hendrie as saying, "We are operating almost totally in the blind, [sic] [Governor Thornburgh's] information is ambiguous, mine is non-existent and—I don't know, it's like a couple of blind men staggering around making decisions . . . ." *Id.*

NRC and Pennsylvania officials about the extent of the accident[208] and some of their post-accident behavior, such as venting steam from the plant[209] and discharging radioactive water into the Susquehanna River.[210] To say that chaos reigned in the days that followed TMI-2 would be an understatement, as critical plant and government personnel, as well as the Governor of Pennsylvania, tried to figure out what had happened, assess the severity of the accident, and determine what the appropriate response should be.[211]

5. Emergency Response Failures

Finally, both the accidents themselves and the subsequent damage might have been avoided, or at least reduced in severity, had operating crews, company management, and government agencies (including state and local governments) been better trained in how to respond to an emergency.[212] In each case,

208. Metropolitan Edison officials were aware a "general" emergency was underway at the plant and were informing local civil defense officials, mayors, and state officials, though they did not tell the NRC until three hours later. Stern et al., *How the Crisis Was Managed*, *supra* note 204.

209. Laurence Stern et al., *A Disturbing Signal of Vented Radiation*, WASH. POST, Apr. 9, 1979, at A1, *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/ch5.htm. Operators vented steam to relieve pressure building up in a plant holding tank without informing state or federal officials, which triggered extraordinary planning actions to protect local residents by these same officials who were unaware that the high radiation levels were not part of "a spreading accident." *Id.*

210. Stern et al., *The Tough Fight to Confine the Damage*, *supra* note 104, at 4 (explaining that the utility flushed radioactive water into the Susquehanna River from the overloaded plant holding tanks without approval of the Pennsylvania Department of Environmental Resources or the NRC, and without telling downstream communities).

211. The NRC Washington headquarters "under-estimat[ed] the seriousness of the accident" in the first forty-eight hours, and then over-reacted by recommending that Pennsylvania Governor Richard Thornburgh evacuate pregnant women and young children and requesting a quarter-million bottles of potassium iodine to block the uptake of radioactive iodine from the Food and Drug Administration. *Three Mile Island: The Inside Story—Five Days of Crisis*, SMITHSONIAN NAT'L MUSEUM OF AM. HIST., http://americanhistory.si.edu/tmi/tmi04.htm (last visited Sept. 3, 2010). The NRC also increased nearby residents' fears by telling reporters there was a possibility of an explosion in the plant, which could require the evacuation of a ten to twenty mile radius. *Id.* at 2.

212. *See* Freudenburg, *supra* note 175, at 14 (explaining how organizational failures create safety risks). Freudenburg uses the *Exxon Valdez* accident to illustrate the importance of being prepared for catastrophic accidents and why drills, in addition to comprehensive response plans, are necessary. The plans in effect on the date of the accident set out plans for the availability and coordinated deployment of response equipment by various agencies and for open and clear channels of communication "among previously competitive or even adversarial organizations," but the reality was quite different. *Id.* at 26. For example,

inadequate planning,[213] training,[214] and communication meant that the key parties involved were not adequately prepared to deal with the risk of a catastrophic accident. The failure to train operators in how to respond to an emergency of the kind that occurred at both facilities and how to "engage" critical equipment like the BOP blind shear ram may have contributed to these systems not being used as intended.[215]

In the case of the offshore oil and gas drilling industry pre-*Deepwater Horizon*, "federal oversight of spill contingency plans largely amount[ed] to accepting what oil industry operators [said] they [could] do, rather than demanding they demonstrate that they actually [could] do it."[216] During the *Deepwater Horizon* emergency, the "mechanical response equipment . . . fell well short

Freudenburg notes that "[c]onfusion seems to have been far more commonplace than communication; a number of important steps either failed to be taken or else fell through the interorganizational [sic] cracks. Rather than coordinating their activities as effectively as the components of a well-designed computer program, the various organizations with a stake in the spill and the clean-up often seemed to have more interest in blaming one another than in working with one another." *Id.*

213. According to the President's Oil Spill Commission, both industry and the government were "woefully unprepared" to respond to and contain the Macondo well blowout—"[a]ll parties lacked adequate contingency planning, and neither government nor industry had invested sufficiently in research, development, and demonstration to improve containment or response technology." COMMISSION REPORT, *supra* note 7, at 243. This insufficiency occurred despite industry promises made after *Exxon Valdez* that it would commit significant funds toward these efforts. *Id.* *See generally* Plater, *supra* note 147 (comparing systemic similarities between the *Exxon Valdez* and *Deepwater Horizon* accidents, and suggesting that Alaska's recommendations from its investigation of the causes and the failures of the oil spill response to the *Exxon Valdez* accident should have informed the response to *Deepwater Horizon* accident).

214. *See* CHIEF COUNSEL'S REPORT, *supra* note 65, at 236 ("BP and Transocean inadequately trained their personnel," specifically with respect to "kick monitoring during end-of-well, nondrilling activities, such as temporary abandonment," and "how to respond to emergency situations," like what happened on the *Deepwater Horizon* drilling rig); *see also* WALKER, *supra* note 107, at 75 (explaining that while TMI operators scored above the national average on NRC qualifying exams, the "experience and training of the operators on duty at TMI-2 when the accident occurred, and of the reinforcements that they soon called in, did not prepare them to cope with the deteriorating conditions in the plant." They had been trained only to respond to minor, routine malfunctions and as a result had not developed "the analytical skills needed to deal with unanticipated problems").

215. COMMISSION REPORT, *supra* note 7, at 122; WALKER, *supra* note 107, at 75; Stern et al., *A Pump Failure and Claxon Alert*, *supra* note 108, at 4.

216. Robertson, *supra* note 1, at A1; *see also* Hoffman, *supra* note 18 (noting that offshore oil spill response plans were "often boilerplate reproductions from one well to another," and noting that the BP Gulf response plan "referenced seals and walruses, which aren't found in that body of water, referred to a home-shopping network in Japan and listed scientists who were dead.").

of . . . [what was] need[ed];" critical booms had to be flown in from Alaska and skimmer boats came from Norway.[217] These measures were necessary, despite the fact that the Oil Pollution Act,[218] supplemented by an Executive Order,[219] imposed "a panoply of oil-spill planning, preparedness, and response requirements on fixed and floating facilities engaged in oil and gas exploration, development, and production on the outer continental shelf."[220] Somewhat belatedly, the new director of the Bureau of Ocean Energy, Management, Regulation and Enforcement (BOEMRE) acknowledged that the *Deepwater Horizon* accident made it clear that offshore oil and gas companies did not have "sufficient containment capacity to respond to a major spill."[221] Given the paucity of equipment, it was no surprise to experts that the oil would not be recovered, let alone contained, for many months.[222]

The March 10, 2009 exploration plan BP submitted to MMS confidently stated that "in the event of an unanticipated blowout . . . [there] is unlikely to [be] an impact based on the industry-wide standards for using proven equipment and technology" to respond to such an occurrence.[223] However, no one in the industry had proven equipment or technology, let alone any contingency plan for a catastrophic accident in water at the depth of the Macondo well.[224] The deepwater drilling industry simply "ha[d] not developed an oil spill plan for the low probability, high-

217. Robertson, *Efforts to Repel Gulf Spill*, *supra* note 1, at A16.

218. 33 U.S.C. §§ 2701–2762 (2006).

219. Exec. Order No. 12,777, 56 Fed. Reg. 54,757 (Oct. 18, 1991); *see* Robertson, *supra* note 1, at A1 (explaining that the Presidential Executive Order supplemented the Oil Pollution Act of 1990).

220. COMMISSION REPORT, *supra* note 7, at 80; *see also* Robertson, *supra* note 1, at A1 ("A year [after the *Exxon Valdez* ran aground] lawmakers passed the federal Oil Pollution Act to ensure that plans were in place for oil spills, so that the response effort would be quick, with clear responsibilities for everyone involved. Every region of the country was required to have a contingency plan, tailored for its unique geography, for responding to a spill.").

221. Jad Mouawad, *4 Oil Firms Commit $1 Billion for Gulf Rapid-Response Plan*, N.Y. TIMES, July 22, 2010, at B9.

222. Robertson, *supra* note 1, at A16 (quoting a response consultant as saying, "I don't think there's a person in the spill world who would have thought that whole thing would be contained and recovered."); *see also* Mouawad, *supra* note 221, at B9 (quoting an energy expert as saying, "Companies have used their technology to get into deep water but they didn't have an adequate plan to intervene at these depths or to contain a large-scale spill," and noting that "[i]t has taken BP nearly three months to finally cap its gushing oil well in the gulf, after repeated failures to plug the well using a series of jury-rigged devices.").

223. Hoffman, *supra* note 18 (internal quotation marks omitted).

224. *Id.*

consequence event when everything fails."[225] When the accident happened, according to a rig worker, "[t]he scene was very chaotic . . . . There was no chain of command, nobody in charge."[226] Although the rig had emergency plans, including places where crew members were to gather in the event of an emergency, the crew had not adequately practiced safety drills.[227] Further, disagreements between Transocean and BP and various government agencies over the size of the spill and possible ways to stop and contain the flow of oil also slowed down the response and in all likelihood made it much less effective than it should have been.[228]

In the case of TMI-2, no evacuation plan existed for residents of nearby towns.[229] Had an evacuation been required, the affected local communities would have had to improvise.[230] At several points during the crisis, phone lines either jammed or went down.[231] The emergency response effort became more organized and effective once the federal government took over planning for any evacuation that might occur.[232] However, tension between the company and the NRC over who was in charge of controlling the accident led to flare ups and conflicting stories about what was

225. *Id.* (quoting Greg McCormack, director of the University of Texas Petroleum Extension Service).

226. *Id.* at 12 (quoting Carlos Ramos, a worker on the drilling rig).

227. *Id.* ("Although the vessel had muster stations and emergency plans, crew members had never practiced safety drills without warning to simulate a real disaster.").

228. Tension existed between the Governor of Louisiana and U.S. Coast Guard spill responders, and state and local officials rejected pre-spill plans and created their own "response structures." *See* COMMISSION REPORT, *supra* note 7, at 138–39. There were conflicting opinions about whether BP should be a "partner" in spill response. *Id.* at 136. There was "no clear line between the National Incident Commander's responsibilities and those of the Federal On-Scene Coordinator," both of whom played roles in the spill response. *Id.* at 136. There were also accounts of "boom wars" between the U.S. Coast Guard, state governors, and local parishes over where booms would be placed to intercept the spill and a "struggle among the State of Louisiana, the Army Corps of Engineers, the National Incident Command, and, ultimately [the] White House over berms." *Id.* at 153–54.

229. *See* Stern et al., *How the Crisis Was Managed*, *supra* note 204.

230. For example, Metropolitan Edison did not tell the mayor of the closest town about the accident until many days later. *See id.*

231. *Id.* at 4; *see also* Stern et al., *A Tough Fight to Confine the Damage*, *supra* note 104, at 4 ("What might be termed the coup de grace to the day's confusions came late Thursday afternoon when all phone communications went out between the Three Mile Island control room and the command post across the river. 'For several hours, there these guys were trying to keep atop of the situation using walkie-talkies . . . . The whole situation—simply incredible.'").

232. *See* Stern et al., *Danger of Day 3*, *supra* note 205 (describing the federal government's $1.7 million preparation for area-wide evacuation and radiation emergency).

happening on-site and whether an evacuation would be required.[233]

B. Indirect Causes of the Accidents

Stepping away from the particulars of the accidents and their direct contributing causes, several problems within the companies that owned and operated the drilling rig and the Unit 2 nuclear power plant may have indirectly contributed to the accidents. Included among these factors are the economic pressures these companies faced and an over-reliance on engineering to avoid or control accidents.

1. Economic Pressures

Economic pressures played an important role in decisions made by the companies that owned and operated the drilling rig and the power plant prior to each accident, and may have caused these companies to cut certain corners and choose the less expensive but more risky approach to several problems. For example, in the aftermath of *Deepwater Horizon,* one worker noted that an atmosphere of "[r]un it, break it, fix it" prevailed on the rig.[234] A confidential survey by Lloyd's Register Group, a maritime and risk-management organization, conducted weeks before the accident reported that many Transocean workers expressed concern about safety practices but feared reprisals for reporting unsafe conditions;[235] others said that crew members may not have

233. Stern et al., *Black Ink, supra* note 162, at A2. Different information being relayed by the federal government and the company left residents wondering what and whom to believe. Lawrence Stern et al., *Inhabitants Wonder What to Believe,* WASH. POST, Apr. 11, 1979, at A1, *available at* http://www.washingtonpost.com/wp-srv/national/longterm/tmi/stories/ch14.htm (describing confusion over the accident's effect on residents' health and loss of trust in the company and nuclear power in general, and commenting on "the seeds of anxiety, distrust and anger sown with the first alarms from Three Mile Island and fertilized by the confusion and contradictions that marked the official response to the crisis").

234. Urbina, *supra* note 151, at A1. According to one article, "[W]orkers said that company plans were not carried out properly and they 'often saw unsafe behavior on the rig.' Some workers also voiced concern about poor equipment reliability, 'which they believed was as a result of drilling priorities taking precedence over planned maintenance.'" *Id.* The same article noted, "Transocean's system for tracking health and safety issues on the rig was 'counter-productive.' Many workers entered fake data to try to circumvent the system, known as See, Think, Act, Reinforce, Track . . . . As a result, the company's perception of safety on the rig was distorted . . . ." *Id.* at A17.

235. *Id.* ("A confidential survey of workers on the Deepwater Horizon in the weeks before the oil rig exploded showed that many of them were concerned about safety practices and feared reprisals if they reported mistakes or other problems."); *see also* COMMISSION REPORT, *supra* note 7, at 224 (describing the survey).

understood the safety protocols.[236] The survey reported that "[o]nly about half of the workers interviewed said they felt they could report actions leading to a potentially 'risky' situation without reprisal," and concluded that "'[t]his fear was seen to be driven by decisions made in Houston, rather than those made by rigbased leaders.'"[237]

According to some, BP also fostered a culture in which unsafe behavior was not uncommon.[238] Before the *Deepwater Horizon* accident, BP "led an industry wave of cost-cutting and consolidation,"[239] slashing costs, firing engineers, and outsourcing many critical functions, which left the company reliant on outside contractors.[240] BP also undertook large, risky projects and employed risky procedures to save time and money without taking adequate steps to "contain the added risk."[241] In this regard, BP

236. CHIEF COUNSEL'S REPORT, *supra* note 65, at 222 ("An April 2010 Transocean assessment also found that the maintenance system was not understood by the crew."). The Lloyd's survey also reported that "Transocean crews 'don't always know what they don't know. [F]ront line crews are potentially working with a mindset that they believe they are fully aware of all the hazards when it's highly likely that they are not.'" COMMISSION REPORT, *supra* note 7, at 224 (quoting CONSULTING SERVICES LLOYD'S REGISTER EMEA ABERDEEN ENERGY, NORTH AMERICAN DIVISION SUMMARY REPORT 29 (2010)).

237. Urbina, *supra* note 151, at A17 (quoting the Lloyd's survey).

238. BP's Chief Executive Officer, Robert Dudley, has denied that "cultural failings at BP" were to "blame" for the "string of accidents." Sarah Lyall, *In BP's Record, a History of Boldness and Costly Blunders*, N.Y. TIMES, July 13, 2010, at A1. Congressman Waxman, however, noted that "'[t]here is a complete contradiction between BP's words and deeds. You [referring to Tony Hayward] were brought in to make safety the top priority of BP. But under your leadership, BP has taken the most extreme risks. BP cut corner after corner to save a million dollars here and a few hours there . . . . And now the whole Gulf Coast is paying the price.'"). *Id. See also* Elana Schor, *Senators Rap BP Official for Record of OSHA Violations*, GREENWIRE (July 22, 2010), http://www.eenews.net/Greenwire/print/2010/07/22/3 (reporting that one member of the Senate committee investigating BP's OSHA record found that "BP's claims to prioritize safety first are 'rather offensive' given its record").

239. Lyall, *supra* note 238, at A14.

240. *Id.* at A14 ("Mr. Browne . . . ruthlessly slash[ed] costs . . . outsourced many operations, and fired tens of thousands of employees, including many engineers."). Another reason why BP and the industry as a whole had an insufficient number of experienced personnel may be because the industry had eliminated most of its research capabilities, and academic research was chronically under-funded. COMMISSION REPORT, *supra* note 7, at 243. Filling such a gap with contract personnel is problematic because of differing cultures and management structures, which, in the case of the Macondo well blowout, led to "conflicts of interest, confusion, lack of coordination, and severely slowed decisionmaking." *Id.* at 229.

241. Lyall, *supra* note 238, at A14 (quoting preliminary findings by the House Energy and Commerce Committee that concluded that "[i]n effect, it appears that BP repeatedly chose risky procedures in order to reduce costs and save time and made minimal efforts to contain the added risk," and also noting that "[u]nlike some of his more cautious competitors, [former BP CEO] Browne ignored small projects and went after the riskiest, most

distinguished itself from some of its competitors.[242] BP's rushed construction and deployment in the Gulf of the sister rig to the *Deepwater Horizon* drilling platform, the *Thunder Horse* drilling rig, is an example of this time and cost-driven insensitivity toward risks.[243] Construction defects discovered on the *Thunder Horse* rig "cost BP and its minority partner, Exxon Mobil, hundreds of millions of dollars in repairs and set production back by three years."[244] Federal records show that BP also had a history of "bypassing safety systems that could impede routine operations,"[245] most notably at its refineries, which received 760 of the 761 egregious and willful

expensive[,] and potentially most lucrative ventures—'elephants,' in industry jargon. Under him, BP's share price more than doubled and its cash dividend tripled, making it a darling of investors."); *see also* Freudenburg, *supra* note 175, at 12 (stating that sometimes "the lack of organizational commitment to risk management may be a predominant source of real risk"); Houck, *supra* note 49, at 11034 (reporting that only twenty million dollars (0.05%) of the thirty-nine billion dollars BP invested in new oil and gas exploration between 2007 and 2010 was spent on research and development to prevent and respond to accidents); *cf.* Kazuo Miura et al., *Characterization of Operation Safety in Offshore Oil Wells*, 51 J. PETROLEUM SCI. & ENGINEERING 111, 111 (2006) (saying that while the term risk analysis "varies widely in the Oil and Gas industry[,] [i]n most cases it denotes a profitability analysis characterizing each project in terms of its probability of reaching commercial production and hence revenue.").

242. *See* Lyall, *supra* note 238, at A14 ("BP is hardly the only oil company that has taken on difficult projects with a shaky safety net. But the company's attitude toward risk stands in contrast to that of its competitors, most notably Exxon Mobil, whose searing experience with the *Exxon Valdez* spill in 1989 spurred a wholesale change in its approach to safety."); *see also* Jad Mouawad, *New Culture of Caution at Exxon After Valdez*, N.Y. TIMES, July 13, 2010, at Op. 1 (attributing Exxon's decision to stop drilling the Blackbeard Gulf exploration well after a kick made drilling team nervous to the implementation of new post-*Exxon Valdez* safety procedures that "empowered everyone, even contractors, to speak up about safety problems," and quoting a Deutsche Bank analyst as saying that while initially Exxon's decision to abandon the well looked like a "lack of guts," after the Macondo well blowout "[it] looks a lot more like justified conservatism and prudence, and a prescient awareness that safety, caution and catastrophic risk avoidance would be key themes as oil companies were forced to push the envelope in the search for new oil.).

243. *See* Lyall, *supra* note 238, at A14 (reporting that "BP's bosses rushed construction of the intricately designed . . . [*Thunder Horse* platform], moving it to the Gulf before it was ready to 'demonstrate to their shareholders that the project was on time and on schedule.'"); *see also* COMMISSION REPORT, *supra* note 7, at 49–50 (describing the problems BP experienced with the five billion dollar *Thunder Horse* project).

244. Lyall, *supra* note 238, at A14 (also noting that after performing costly repairs in response to damage caused by an incorrectly installed check valve, "BP discovered . . . rudimentary mistakes in the welding of pipes in the underwater manifold, which connects dozens of wells and helps carry the oil back to the platform, had caused dangerous cracks and breaks.").

245. Hilzenrath, *supra* note 177, at 1 ("Records of federal enforcement . . . show that, in case after case, rig operators paid fines for allegedly bypassing safety systems that could impede routine operations.").

OSHA violations levied on refineries within a three-year period.[246] Although BP maintains that it has "learned how to balance risk and safety, efficiency, and profit," the record appears quite different.[247] Indeed, as one industry expert has suggested, it is possible that BP was "fooled" by its economic success;[248] in slightly over a decade, "BP grew from a middleweight into the industry's second largest company, behind only Exxon Mobil, with soaring profits, fat dividends, and a share price to match."[249]

It appears that BP managers on the *Deepwater Horizon* drilling rig, when called upon to make a risk-based decision, often chose the cheapest solution, even when doing so elevated the risk of an accident.[250] This behavior "steadily whittled away at the margin of error until there was no margin left."[251] Many of the anomalies that federal regulators found in the construction of the Macondo well involved instances in which well-known industry protocols were not followed in favor of time and cost saving practices.[252] An official

246. *See* Elana Schor, *Senators Rap BP PLC Official for Record of OSHA Violations*, GREENWIRE (July 22, 2010), http://www.eenews.net/Greenwire/print/2010/07/22/3 (discussing BP's poor refinery safety record and reporting that "BP had received 760 out of the 761 egregious and willful OSHA violations slapped on refiners over the past three years."); *see also* Lyall, *supra* note 238, at A14 (noting that a year after the Texas City refinery explosion, "267,000 gallons of oil leaked from BP's network of pipelines in Prudhoe Bay, Alaska," making it "the worst spill ever on the North Slope," and saying "the cause was preventable . . . corrosion in several miles of under-maintained and poorly inspected pipes. BP eventually paid more than $20 million in fines and restitution."). The leak went undetected for five days. COMMISSION REPORT, *supra* note 7, at 222.

247. Lyall, *supra* note 238, at A14 ("Time and again, BP has insisted that it has learned how to balance risk and safety, efficiency and profit. Yet the evidence suggests that fundamental change has been elusive.").

248. *Id.* (quoting Steve Arendt, a safety specialist who was appointed by BP to investigate the Texas City explosion).

249. *Id.* at A1.

250. Achenbach & Hilzenrath, *supra* note 61 (saying that BP "chose the least expensive option even though it potentially elevated the risk."). *See also* CHIEF COUNSEL'S REPORT, *supra* note 65, at 135–39 (recounting various corner cutting incidents, such as prematurely setting a lock down sleeve during temporary abandonment process to save five and a half days and two million dollars, and replacing expensive drilling muds with sea water before setting backup barriers to hydrocarbon flow even though there were available alternative procedures, which under-balanced the well and created significant, unnecessary risks). The *Deepwater Horizon* drilling rig was not the only BP rig that experienced problems. *See* Lyall, *supra* note 238 (discussing problems at another Gulf BP rig, where a valve installed backwards "caused the vessel to flood during the hurricane, jeopardizing the project before any oil had even been pumped," and saying that "[t]he problems at Thunder Horse were not an anomaly, but a warning that BP was taking too many risks and cutting corners in pursuit of growth and profits, according to analysts, competitors and former employees.").

251. Achenbach & Hilzenrath, *supra* note 61.

252. *Investigators Highlight 20 'Anomalies' in Hours Before Well Blowout*, GREENWIRE (July 19,

responsible for monitoring the drilling rig observed in hearings after the accident that he approved a drilling plan that many other experts in the industry described as "deeply flawed."[253] Time and money were major concerns for BP because the well was significantly behind schedule. In fact, at the time of the accident, the rig, which had cost BP approximately half a million dollars a day to lease,[254] was forty-three days late for its next drilling location.[255] These scheduling problems, when combined with a cost-cutting culture, put a higher premium on improving drilling efficiency than on safety, with the result that "engineering and operations decisions tilted toward cost and time savings."[256]

Similar economic pressures may have pushed Metropolitan Edison to make risky decisions at TMI-2. One such decision might have been the company's push to bring Unit 2 up to full power before the problems that had plagued its startup were completely solved. By bringing the plant to full power before the end of the federal tax year, the company saved approximately forty million dollars in taxes.[257] It also increased the likelihood that the

2010), http://www.eenews.net/Greenwire/print/2010/07/19/8.

253. Marc Kaufman, Carol D. Leonnig, & David Hilzenrath, *MMS Investigations of Oil-Rig Accidents Have History of Inconsistency*, WASH. POST, July 18, 2010, at A1, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2010/07/17/AR2010071702807.html ("[A] veteran investigator . . . responsible for monitoring the Deepwater Horizon rig . . . testified that he approved a BP drilling plan that other oil companies and drilling experts have said was deeply flawed.").

254. *See* CHIEF COUNSEL'S REPORT, *supra* note 65, at 245 (reporting that the BP *Deepwater Horizon* drilling lease cost almost $533,000 a day, making it "the single greatest expense for drilling the Macondo well").

255. The Macondo well was almost six weeks behind schedule on the date of the accident and more than fifty-eight million dollars over budget. COMMISSION REPORT, *supra* note 7, at 2; *see also* John Adams Hodge, *How Environmental Regulators Can Address Human Factors in Oil Spill Prevention Using Crew Resource Management*, 40 ENVTL. L. REP. 11048, 11049 (2010) (stating that after reviewing reports discussing a BP official's direction to replace drilling mud with seawater over the chief driller's protests, "it is appropriate to ask whether the desire to make up lost time in the drilling schedule, the attitude of rig workers toward raising safety concerns, and the presence of management on the rig, among other factors, were contributing causes to the oil spill.").

256. CHIEF COUNSEL'S REPORT, *supra* note 65, at 245. The Chief Counsel's report goes on to list "[e]xamples of decisions that increased risk at Macondo while potentially saving time," including not running a cement evaluation log, not performing additional well integrity tests after unexpected results from the negative pressure test, not installing additional barriers during temporary well abandonment, setting the cement plug closer to the wellhead, using fewer than the recommended number of well centralizers, and displacing mud from the drill pipe before setting the surface cement plug. *Id.* at 245–46.

257. Stern et al., *Black Ink*, *supra* note 162, at A2 ("The company was able to claim about $20 million for six months' federal tax depreciation by getting TMI 2 into service before the

company would receive a requested rate increase from the public service commission and improve the company's rate of return on its common stock.[258] Further, as one scholar has noted, prior to TMI-2, nuclear utility executives prioritized the continuous operation of nuclear power plants; repairing a plant meant that it would be shut down, thus reducing electrical output.[259] This created a similar mindset to that found on the *Deepwater Horizon* rig prior to the Macondo well blowout—"running the machinery until it broke."[260] Although Metropolitan Edison denied that safety had been compromised in the push to bring the plant up to full power,[261] it is possible that management's emphasis on power production contributed to a safety climate at Unit 2 in which accidents were more likely to happen than not.[262]

2. A Focus on Engineering as the Primary Barrier Against an Accident

A second, less obvious contributing factor to the accidents may have been the excessive reliance of both industries on engineered solutions to problems. Engineers share a faith in engineered

end of the year . . . and between $17 million and $28 million in investment tax credits—direct writeoffs.").

258. *Id.* at A1. Metropolitan Edison's annual report commented on the tax advantage gained by putting the plant in service. *Id.*

259. *Id.* at 23–24 ("The *costs* of repair and maintenance were obvious, in the eyes of industry officials, while the *benefits* were vague and uncertain. Hence these were low priorities."). It has also been noted that "the pre-TMI nuclear industry was composed of inward-looking and production-oriented utilities." *Id.* at 24. A similar concern motivated rig operators to make a series of decisions about well-cementing procedures out of concern that the fragile geologic formation they were drilling into might fracture and lead to "lost returns." COMMISSION REPORT, *supra* note 7, at 99–100.

260. REES, *supra* note 106, at 23.

261. *See* Stern et al., *Black Ink, supra* note 162, at A1 ("Creitz conceded to reporters after the accident that Met Ed had gained tax advantages by getting TMI 2 into service in 1978. But he and John G. Herbein, his vice president for power generation, insisted that there had been no 'rush' to beat the calendar at the expense of safety.").

262. *See* Kathryn Mearns, Sean M. Whitaker, & Rhona Flin, *Safety Climate, Safety Management Practice and Safety Performance in Offshore Environments*, 41 SAFETY SCI. 641, 642 (2003) (saying a "safety climate" is how a safety culture manifests itself in "the behaviour and expressed attitude of employees."). The authors identify several aspects of a company's safety climate, including "management commitment, supervisor competence, priority of safety over production, and time pressure," which "emerge as predictors of unsafe behaviour or accidents in numerous . . . models." *Id.*; *see also* Bernhard Wilpurt, *The Relevance of Safety Culture for Nuclear Power Operations*, *in* SAFETY CULTURE IN NUCLEAR POWER OPERATIONS 4 (Bernhard Wilpurt & Naosuke Itoigawa eds., 2001) ("Safety culture, as a distinct and holistic concept, first entered scientific discourse in the aftermath of the Chernobyl catastrophe and is now adopted and adapted by virtually all high-hazard industries.").

solutions to technical problems.[263] To some extent, they are conditioned to think that mathematically-based, theoretical approaches to technical problem-solving are more rigorous, and hence more valid, than approaches that emphasize "the importance of qualitative considerations based upon practical experience."[264] This type of mindset thrives in both the nuclear and offshore drilling industries, which are often on the cutting edge of problem-solving. The outlook of the NRC prior to TMI-2 provides a strong example of this type of thinking. Because the NRC considered the likelihood of a catastrophic accident to be remote, it did not require applicants for nuclear licenses to make necessary contingency plans given how the plants were engineered,[265] and instead focused narrowly on equipment design and performance.[266] Some say that the hubris of the nuclear industry[267]—its sense of invincibility and reliance on engineering

263. *See, e.g.*, Donald C. Jackson, *Considering the Multiple Arch Dam: Theory, Practice and the Ethics of Safety in a Case of Innovative Hydraulic Engineering*, 32 NAT. RESOURCES J. 77, 77–78 (1992) ("When considering water resources development and the decisionmaking process that controls how hydraulic technologies are implemented, historians and public policy professionals often view engineering projects as representing a 'single-best' solution to a problem. After all, modern engineers are supposedly trained to provide efficient, scientific answers which, although some parties may find them to be politically or socially undesirable, comprise rational reactions to a situation."); *see also* Broad, *supra* note 17, at D3 ("[E]ngineering, by definition, is a problem-solving profession."). *See generally* Nathan Caplan & Stephen D. Nelson, *On Being Useful: The Nature and Consequences of Psychological Research on Social Problems*, 28 AM. PSYCHOLOGIST 199, 202–03 (1973) (citing Abraham Kaplan's "law of the instrument," which contends that experts tend to view solutions to problems in terms of their specialized knowledge. "It comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is especially skilled.").

264. Jackson, *supra* note 263, at 78. Even though a technical solution to a problem may not always be best, "society as a whole is reluctant to abandon the notion that engineering is an exact science capable of developing ideal responses to technological quandaries." *Id. But see* Broad, *supra* note 17, at D3 (quoting a British engineer describing structural engineering as "the art of molding materials we do not really understand into shapes we cannot really analyze, so as to withstand forces we cannot really assess, in such a way that the public does not really suspect.").

265. *See* REES, *supra* note 106, at 30 ("[N]uclear plant hardware was the regulator's foremost defense against nuclear accidents.").

266. Chandler, *supra* note 141, at 493.

267. *See* REES, *supra* note 106, at 12–13 (quoting an industry official commenting on the "traumatic shock" to institutions involved in the commercial use of nuclear power and saying it was "a shock we needed because of the hubris with which we all picked up the momentum of the nuclear age," by which he meant that "nuclear power moved from the first submarine experience to commercial application, to large-scale use in thousand megawatt plants in such a short time that there was little potential for adequate feedback of experience into the overconfident but naïve organizations who . . . operated the new plants.").

rather than shared practical experiences—combined with the rapid development of the industry (absent any serious incidents and subsequent shared reflection) made an accident of the magnitude of TMI-2 inevitable.[268] Similarly, the deepwater drilling industry believed that its wells could not fail because of how they were engineered and, therefore, provided for only minimal redundancy in the well closure procedures.[269] However, as the two accidents show, "the scientific and 'rational' nature of modern technology is not always as absolute" as people might like to think it is; "[r]egardless of our desires, safety remains a relative value that only has meaning in terms of how people choose to evaluate a wide range of factors and influences,"[270] not just the performance specifications of equipment.

Too narrow a focus on engineering can also lead individuals and companies involved in risky activities to become so reliant on those systems that they forget to be afraid.[271] An internally-perceived good safety record or a sufficient number of years without a major accident may create a sense of complacency about a recurrence of

268. Freudenburg, *supra* note 175, at 12 (reporting on the Kemeny Commission Report, and saying it "began its investigation looking for problems of hardware, but wound up concluding that the overall problem was one of humans—a pervasive 'mind-set' in the nuclear industry at the time, reflecting a problem of organizational hubris that contributed substantially to the likelihood of accidents."). Another problem the Kemeny Commission discovered was the dominance of nuclear regulatory requirements, compliance with which not only consumed the efforts of utility officials, but also created an atmosphere where regulatory compliance—"going by the book"—was "equated with safety," breeding complacency and a disinclination to do more. REES, *supra* note 106, at 19–20.

269. An example of this was the failure of BP or Transocean to have redundant on-shore monitoring of what was happening on the rig, especially during the negative pressure tests. *See* CHIEF COUNSEL'S REPORT, *supra* note 65, at 242.

270. Jackson, *supra* note 263, at 100. Jackson goes on to say that what follows from this thought is that "society, and the legal system, cannot afford to relinquish responsibility over the technological decision-making process to experts without appreciating the traditions and technical prejudices that may color their view of what is safe and/or acceptable." *Id.*

271. Gold & Casselman, *supra* note 15, at A1; *see also* COMMISSION REPORT, *supra* note 7, at 230 (describing changes made in the Navy's nuclear submarine program after the sinking of the *Thresher*, including a new "questioning attitude . . . [that] the officers called *chronic uneasiness*, summarized in the saying, '[t]rust but verify.'" (quoting NANCY LEVESON, ENGINEERING A SAFER WORLD: SYSTEMS THINKING APPLIED TO SAFETY 379 (2012)); *see also* Senate Three Mile Island Hearing, *supra* note 16 (statement of Gregory B. Jaczko, Comm'r, Nuclear Regulatory Comm'n) (quoting from the Rogovin Report, a study commissioned by the NRC after TMI-2, which found that "[b]efore March 28, 1979, an attitude of complacency pervaded both the industry and the NRC—an attitude that the engineer-designed safeguards built into today's plants were more than adequate, that an accident like that at Three Mile Island would not occur in a particular jargon of the industry, that such an accident was not a credible event.").

an accident.[272] In the nuclear industry, one industry expert noted that the lack of a major accident in the twenty-five years preceding TMI-2 caused an attitude to develop that "nothing bad happens . . . [and] nothing ever will."[273] Technological advances in the deepwater drilling industry, led by BP and Transocean, drove the process at a rate that many thought was unsafe.[274] Offshore drilling in the Gulf of Mexico "was one of the last cowboy environments" in the industry.[275] What had been impossible a few years earlier became "routine" as the two companies "banged out record firsts on the farthest frontiers of technology and geography."[276] There was a complete "lack of a sense of vulnerability within the industry."[277]

The "typical or 'engineering' responses to [a] problem" may exacerbate this sort of conduct by making the work even more routine and boring, to the extent that it requires the employee merely to monitor equipment that automatically runs a system—

272. *See* Freudenburg, *supra* note 175, at 21 (referring to the *Exxon Valdez* accident and stating that "[i]t is entirely possible that the accident of Good Friday, 1989, would not have occurred but for the tragic complacency engendered by the dozen good years that had passed before. More specifically, it may have been the very 'success' of earlier trips in and out of Prince William Sound—literally thousands of them—that helped to make possible a situation where the captain had retired to his quarters, the ship was under the control of a third mate who would not have been expected by a formal risk assessment to be at the helm and the Coast Guard personnel on duty were not bothering to monitor even the lower-power radar screens that remained at their disposal after cost-cutting efforts of a few years earlier.").

273. Hoffman, *supra* note 18 (quoting Larry Foulke, former president of the American Nuclear Society); *see also* KEMENY COMMISSION REPORT, *supra* note 15, at 9 ("After many years of operation of nuclear power plants, with no evidence that any member of the general public had been hurt, the belief that nuclear power plants are sufficiently safe grew into a conviction."). An extreme example of the belief that a catastrophic nuclear accident could not happen was the decision not to have a containment dome on the Chernobyl reactor. Hoffman, *supra* note 18.

274. Bob Herbert, Op-Ed., *We're Not Ready*, N.Y. TIMES, July 20, 2010, at A23 (quoting the director of the National Center for Disaster Preparedness at Columbia University's Mailman School of Public Health, who said that "[w]e are way, way behind when it comes to the hard work of preventing accidents and responding to these catastrophes when they happen. With deep-water oil drilling, we allowed the technological advances to drive the process at a rate that was unsafe, and we got really badly burned.").

275. Hoffman, *supra* note 18 (quoting Steve Arendt, an industry expert).

276. *Id.* A Duke University civil engineering professor, Henry Petroski, observed that "when you think you've got a robust system . . . you tend to relax." *Id.*

277. *Id.* (quoting Steve Arendt, an industry expert). This blind faith in engineered solutions seems somewhat quixotic when applied to the *Deepwater Horizon's* blowout preventer, which Transocean had identified as having 260 separate potential means of failure. *Id.* at 3. This fact led Representative Bart Stupak (D-Mich.) to ask, "How can a device that has 260 failure modes be considered fail-safe?" *Id.*

except when there is an emergency.[278] Such jobs are sometimes described as "involving '99% boredom and 1% sheer terror.'"[279]

Perhaps this reliance on engineering is why, prior to the accidents described earlier, both industries displayed an institutional lack of concern about the possibility of serious accidents occurring and, as a result, a lack of attention to avoidance and containment.[280] Using the *Exxon Valdez* accident as an example of the offshore oil and gas industry's unwillingness to take the risk of an accident seriously, William Freudenburg writes that a contingency plan to avoid a tanker disaster in Prince William Sound that had been developed a decade before the *Exxon Valdez* accident was systematically dismantled "piece by piece," prior to the accident,[281] and that the industry ignored lessons that it might have learned from emergency preparedness drills conducted prior to the spill.[282] With respect to the *Deepwater Horizon* accident, the immediate negative effect of this attitude was that there were too few containment booms and oil skimmers on hand to respond to the spill and a crew that had not been trained in how to respond to such an accident.[283] The offshore oil and gas industry was (and still

278. Freudenburg, *supra* note 175, at 8.

279. *Id.* ("[M]ost people do better if the systems they operate require them to remain attentive, even at the cost of considerable tension or pressure."). Freudenburg has noted that "'[i]t's hard to make anything idiot-proof—idiots are far too clever.' The problem is particularly pernicious in the case of systems that are estimated to have extremely low probabilities of failure." *Id.* at 7 (quoting Charles McCoy, *Broken Promises: Alyeska Record Shows How Big Oil Neglected Alaskan Environment*, WALL ST. J., July 6, 1989, at A1).

280. Freudenburg, *supra* note 175, at 13 (describing the *Exxon Valdez* accident "as reflecting a relatively pervasive lack of concern by both Exxon and Alyeska with the companies' own risk management plans."); *see also* REES, *supra* note 106, at 21 (attributing part of the explanation for the "[nuclear] industry's fixation on NRC regulations" and its failure to take precautionary measures beyond those regulations to its "normative system's hardware-centered approach to nuclear safety," and saying that the "pre-TMI normative system . . . [was] concentrated on hardware related issues—how nuclear plants should be designed and constructed—while hardly any notice was taken of the institutional arrangements and processes required to manage, operate, and maintain these plants.").

281. Freudenburg, *supra* note 175, at 22 (discussing the consequences of emergency plans "occupying organizationally peripheral positions" in relation to the piecemeal dismantling of the *Exxon Valdez* plan).

282. *Id.* at 25 ("In the case of the Alaska oil spill, the 'drills' on emergency preparedness conducted before the spill might have suggested to astute observers the need for greater attention to spill response. Neither the equipment nor the organizations worked as planned, and the drills 'sometimes were near-disasters themselves.' Such lessons, however, were evidently overlooked." (footnote omitted) (quoting McCoy, *Broken Promises*, *supra* note 279, at A4)). Freudenburg also notes that "at least five contingency plans were in effect at the time of the spill." *Id.*

283. *See generally supra* Part II.A.5 (discussing the lack of emergency preparedness training

is) in "total denial" about the risks of its operations[284]—describing what happened on the *Deepwater Horizon* rig as a "low probability, high consequence event,"[285] and blinding itself to the possibility of future well blowouts.[286]

This Part of the Article has revealed the similarities between the direct and indirect causes of the *Deepwater Horizon* accident and the partial nuclear core meltdown at TMI-2, which makes the next Part's discussion of the differences in the responses of the two industries surprising. Together, the two parts raise what should be an obvious question: why have the reactions of the two industries to their respective major accidents been so different when the causes were so similar? The answer to this question is addressed in the final part of this Article.

III. HOW THE OFFSHORE OIL AND GAS INDUSTRY AND THE NUCLEAR INDUSTRY RESPONDED INCONSISTENTLY TO THEIR RESPECTIVE CATASTROPHIC ACCIDENTS

> "The study of failure teaches humility, caution, and the need to question assumptions."[287]

Given the many parallels between the causes of the two accidents, the anemic response of the deepwater drilling industry and the Department of the Interior to *Deepwater Horizon*, when compared to the substantially more robust response of the nuclear industry to

and associated equipment to respond to the well blowout).

284. Gold & Casselman, *supra* note 15, at A1 (quoting engineering consultant David M. Pritchard); *see also* Hoffman, *supra* note 18 (quoting Steve Arendt, an industry expert, as saying that BP viewed its Texas City refinery accident as a "one-off" event, not something "systematic and pervasive," and that "[t]hey were arrogant and proud of the systems they had in place. They were in denial.").

285. Gold & Casselman, *supra* note 15, at A1; *see also* Plater, *supra* note 147, at 11046 (stating that BP, supported by other oil companies and dependent Gulf Coast communities, is asserting "the exceptional status of the Deepwater Horizon blowout, the need to press on with deepwater drilling, and the reasonableness of risks being managed in the Gulf.").

286. Gold & Casselman, *supra* note 15, at A1. The oil industry also characterized the 1969 Santa Barbara Oil Spill and the *Argo Merchant* oil tanker accident as "isolated events" in "a safety-conscious industry." Rick S. Kurtz, *Coastal Oil Pollution: Spills, Crisis, and Policy Change*, 21 REV. OF POL'Y RES. 201, 214, 216 (2004) (explaining the oil industry's strategy of portraying individual accidents as isolated events, as "opportunit[ies] to enhance an already safety conscious industry," and as unfortunate, but necessary, consequences of undertaking risks necessary "to meet the nation's energy needs and ensure economic progress").

287. Jim Meigs, Editor's Note, *How BP Ignored History's Lessons*, POPULAR MECHANICS, Oct. 2010, at 12.

the partial nuclear core meltdown at TMI-2, is puzzling.[288] Since the accident, the offshore oil and gas industry has resisted numerous efforts to strengthen regulatory requirements.[289] Moreover, none of the changes industry leaders or Department officials have proposed is directed at improving the safety culture in which deepwater drilling for oil operates.[290] By contrast, in the

288. Another example of a quick response to a catastrophic accident involving nuclear power was the Navy's response to the loss of the atomic submarine *Thresher*, where fifty-four days after the accident a new SUBSAFE system was established that focused on maintaining the submarine hull's watertight integrity and the operability and integrity of critical systems, thereby controlling accidents and facilitating recovery from flooding hazards. *See* COMMISSION REPORT, *supra* note 7, at 230.

289. *See, e.g.*, *API Responds to Offshore Energy Proposal*, UNITED PRESS INT'L (Sept. 14, 2011), http://www.upi.com/Business_News/Energy-Resources/2011/09/14/API-responds-to-offshore-energy-proposal/UPI-10841315997989 (quoting Erik Milito, director of upstream activity at the API, who stated that "[a]ny additions to already intricate regulatory processes should allow for new exploration and responsible development of our domestic offshore energy resources without unpredictable barriers or delays."); Jennifer A. Dlouhy, *Regulator Confronts Critics in Oil Industry*, HOUS. CHRON., Sept. 13, 2011, http://www.chron.com/business/energy/article/Regulator-confronts-critics-in-oil-industry-2169246.php (stating that "[d]espite finding common ground on the new rulemaking, some oil industry representatives have tangled with regulators over other rules and the pace of permitting since the deadly explosion and oil spill," and quoting the head of BOEMRE, Michael Bromwich, as saying "[t]hese groups continue to distort the facts, and, in some cases, use undisclosed or incomprehensible methodologies to suggest that the slower pace of plan and permit approval is part of a strategy to slow down offshore energy."); Amy Harder, *One Year After the BP Spill: What's Changed and What Hasn't*, GOV'T EXECUTIVE (Apr. 20, 2011), http://www.govexec.com/dailyfed/0411/042011-bp-anniversary.htm ("As much as API has done to lead on the regulatory and safety front, it has also launched a war against the administration and congressional Democrats."); Jennifer A. Dlouhy, *Oil Spill Panel Ideas Face Political, Industry Resistance*, HOUS. CHRON., Jan. 11, 2011, http://www.chron.com/business/energy/article/Oil-spill-panel-ideas-face-political-industry-1683913.php ("Oil and gas industry leaders stressed they already are making changes, and blasted a prime commission finding that the disaster exposed widespread safety problems . . . . Industry representatives reacted coolly to the commission's call for new offshore drilling fees as a way to fund new regulations and resources at the Interior Department's Bureau of Ocean Energy Management, Regulation and Enforcement."); Loren Steffy, *Oil Industry Can't Have It Both Ways*, HOUS. CHRON., Aug. 16, 2010, http://www.chron.com/business/steffy/article/Loren-Steffy-Oil-industry-can-t-have-it-both-ways-1703033.php ("API wants to put the brakes on congressional zeal for new regulations aimed at preventing another disaster."); *see also* Katie Howell, *New Reports Detail Lax Federal Oversight*, GREENWIRE (Feb. 9, 2011), http://www.eenews.net/Greenwire/print/2011/02/09/7 [hereinafter Howell, *New Reports Detail Lax Federal Oversight*] ("Government regulation of offshore drilling has been poorly funded, under industry assault, and plagued by bureaucratic confusion.").

290. Ross, *supra* note 179, at 8 ("The real job of regulation is to alter incentive structures so that the necessary institutions and attitudes, referred to as 'safety culture,' are created within the organizations that do the work."); *see also* Mearns et al., *supra* note 262, at 642 (defining safety culture as an "assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an over-riding priority plant safety issues receive the attention warranted by their significance," and noting the importance of a safety culture

aftermath of TMI-2, the nuclear industry and the NRC immediately implemented numerous changes that responded to the direct and indirect causes of the accident.

A. The Response of the Offshore Oil and Gas Industry and the Department of the Interior to the Macondo Well Blowout

> "I think it would be a mistake to dismiss our experience of the last year simply as a 'black swan,' a one-in-a-million occurrence that carries no wider application for our industry as a whole."[291]

The deepwater drilling industry has made changes since the Macondo well blowout; however, industry skeptics might view much of what it has undertaken as geared towards deflecting further government regulation and convincing the Department of the Interior, as well as Congress, that it should be allowed to resume deepwater drilling in the Gulf.[292] For example, some questioned whether a July 2010 commitment of one billion dollars by four of the largest oil companies in the world to create a rapid-response system to deal with deepwater oil spills in the Gulf[293] was part of an

"because it forms the context within which individual safety attitudes develop and persist and safety behaviors are promoted." (citation omitted). For a more detailed definition of safety culture, see SAFETY CULTURE IN NUCLEAR POWER OPERATIONS xix (Bernhard Wilpurt & Naosuke Itoigawa eds., 2001) (saying that the term "safety culture" covers "all relevant actors in their nuclear safety-oriented interorganizational [sic] relations" and includes "the four phases of thinking about safety: technology, individuals, the interactions of the social and technical subsystems, and the interorganizational relationships in their impacts on systems safety").

291. Clifford Krauss, *BP Chief Says Industry Must Change to Guard Against Spills*, N.Y. TIMES, Mar. 9, 2011, at B9 (quoting BP's Chief Executive Officer, Robert Dudley, in a public address to oil industry executives).

292. *See supra* note 285. In October 2011, the Obama administration granted BP its first drilling permit in the Gulf since the *Deepwater Horizon* accident. *See* Clifford Krauss, *BP to Drill Again in the Gulf of Mexico*, N.Y. TIMES (Oct. 26, 2011, 3:05 PM), http://green.blogs.nytimes.com/2011/10/26/bp-to-drill-again-in-the-gulf-of-mexico/?ref=gulfofmexico2010#. No new legislation has emerged from Congress in response to the spill. *See* Katie Howell, *Will the Latest Gulf of Mexico Spill Report Prompt Any Legislative Action?*, N.Y. TIMES, Sept. 15, 2011, http://www.nytimes.com/gwire/2011/09/15/15greenwire-will-the-latest-gulf-of-mexico-spill-report-pr-13000.html.

293. Mouawad, *supra* note 221, at B1, B9 (saying oil company executives admitted the spill served as "wake-up call" for an industry that had "invested billions of dollars to develop oil and gas resources in ever-deeper waters offshore, but neglected to devise spill-response technology that would be effective in thousands of feet of water"). Commenting on the system, Exxon Chairman Rex W. Tillerson said, "It's doubtful we will ever use it, but this is a risk-management gap we need to fill in order for the government and the public to be confident to allow us to get back to work." *Id.*

attempt to deflect several bills pending in Congress that threatened to limit or end deepwater drilling in the region.[294] The money was used to fund a new company, called the Marine Well Containment Company, which offers modular containment equipment that can be mobilized within twenty-four hours of a spill and operate at the site of a spill within weeks.[295] Although the President's Oil Spill Commission praised the concept, the Commission also criticized the initiative for its limited scope and the potential lack of long-term commitment by the industry.[296] To show that it is capable of self-regulation, the industry also established an industry-wide task force to consider new safety standards, more frequent rig inspections, and new requirements, including certification for blowout preventers and general improvements in the design of wells.[297] As of the writing of this article, three separate task forces—addressing offshore safety, oil spill response preparedness, and subsea well control—have proposed recommendations to the Department of the Interior.[298]

However, the industry as a whole has refused to accept that what happened on the *Deepwater Horizon* drilling rig reflected an industry-wide problem. Senior executives at other oil companies have issued statements saying that they would have designed the Macondo well differently and that "the accident would not have happened had rig workers and their supervisors followed industry

294. *Id.* at B9 ("Oil companies hope the initiative, the product of four weeks of intensive efforts involving 40 engineers from the four companies, will help persuade government regulators and the administration to allow them to resume offshore drilling in the Gulf of Mexico as soon as possible. Oil companies are also seeking to deflect a series of bills being considered in Congress."); *see also* Phil Taylor, *Permit Delays Could Have Dire Economic Impacts, Industry Study Warns*, GREENWIRE (Jan. 25, 2011), http:www.eenews.net/Greenwire/print/2011/01/25/6 [hereinafter Taylor, *Permit Delays*] (reporting that an API official recommended containment services provided by Marine Well Containment Co. and Helix Energy Solutions Group Inc. as a way for the government to restart the offshore oil and gas production process).

295. COMMISSION REPORT, *supra* note 7, at 244.

296. The President's Oil Spill Commission criticized the new company because it is designed to respond only to a Macondo-type well blowout, and not, for example, to a spill like the *Ixtoc I* blowout, where the rig collapsed on top of the well. COMMISSION REPORT, *supra* note 7, at 244–45. In addition, the company's spill-response equipment cannot go as deep underwater as currently available drilling technology. *Id.* There is concern that the new company might share the fate of a similar company the industry created after the *Exxon Valdez* accident but did not financially support. *Id.*

297. Mouawad, *supra* note 221, at B1.

298. Press Release, API, Oil and Natural Gas Industry Calls for Offshore Safety Changes (Sept. 7, 2010), *available at* http://www.api.org/Newsroom/call-safety-changes.cfm.

procedures, conducted adequate tests, and been properly trained."[299] Perhaps this is one reason why the industry has not yet acted on the Oil Spill Commission's recommendation to develop an independent safety organization modeled on the Institute of Nuclear Power Operations (INPO).[300] Like its nuclear counterpart, such an organization might help the industry improve its overall safety record, promote a stronger safety culture within the industry, and develop performance objectives for individual companies.[301] Nor has the industry responded to the Commission's concern about decreased industry support for internal and external academic research, which has, among other things, decreased the availability of experienced personnel who "can grasp the complexity of offshore operations and make quick and correct decisions."[302]

BP as a company has failed to overhaul its inadequate safety culture, one of the main causes of the well blowout, in responding to the accident. BP's immediate post-accident response was to launch a public relations campaign to deflect the negative publicity concerning the spill, which has been the industry's typical response to an accident.[303] Their campaign included a glossy brochure

299. Krauss, *supra* note 291, at 9.

300. COMMISSION REPORT, *supra* note 7, at 234–41 (noting parallels between the nuclear and oil industries that would support adopting an organization modeled after INPO, but cautioning against wholesale adoption of the INPO model); *see also infra* notes 356–360 (discussing INPO in more detail). INPO was created in response to a recommendation of the Kemeny Commission that such an organization be created to perform the dual functions of developing safety standards and systematically auditing both industry and individual plant performance. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 68.

301. *See* COMMISSION REPORT, *supra* note 7, at 235 (describing INPO). The Commission was much enamored by this "self-policing" idea and credited it with improving nuclear power plant efficiency, significantly reducing the number of automatic emergency reactor shutdowns per year, and reducing collective radiation accident rates by a factor of six compared to the 1980s. *Id.* at 239; *see also* Hodge, *supra* note 255, at 11050–56 (describing and touting the benefits of the civil aviation administration's "Crew Resource Management" program and "Aviation Safety Action Reporting Program," and proposing the implementation of similar programs in the oil industry).

302. COMMISSION REPORT, *supra* note 7, at 229 (quoting the chair of the University of Texas' Department of Petroleum and Geosystems Engineering). It also does not appear that the industry has acted on the Oil Spill Commission's recommendation that it "benchmark" its 1993 safety and environmental standards against globally recognized best practices and update those standards immediately. *Id.* at 242.

303. *See* Kurtz, *supra* note 286, at 212 (noting that between 1960 and the early 1970s, "[i]mage manipulation," whereby spills "were portrayed as anomalies in a safety conscious industry," was commonly used to maintain the status quo); *cf.* Schleifstein, *BP Reneges on Deal, supra* note 83 (reporting that state wildlife officials who complained about BP's decision not to pay Louisiana to "rebuild oyster beds, repair damaged wetlands and build a fish hatchery"

setting out the company's recommendations for preventing future accidents and touting "advances" made in managing hydrocarbons and well-control fluids, the use of dispersants, and improvements in operational coordination and risk management.[304] Following the immediate aftermath of the accident, BP finally joined the industry's billion dollar effort to build a rapid response oil containment system in the event of another accident in late September 2010, contributing underwater well containment equipment and offering its technical personnel to "advise the group in its effort to develop spill-response equipment."[305] In the summer of 2010, BP also established a new division to monitor the safety of its operations, which led to the suspension of some operations in Alaska and the North Sea when the projects failed to meet the new safety standards.[306] While these initiatives show promise of some change in BP's safety mindset, time will tell whether the company's culture has actually changed and whether

suggested that the decision reflected BP's move from a public relations strategy to a litigation strategy, focused on disputing BP's liability for damage to the state's oyster beds).

304. Marc Kaufman, *BP Says Lessons from Gulf Spill Could Prevent More Incidents*, WASH. POST, Sept. 3, 2010, at A4 (reporting on recommendations contained in BP's "glossy 'Lessons Learned'" report issued on Sept. 2, 2010); *see also* Plater, *supra* note 147, at 11046 (commenting that "BP has been far more successful than Exxon in removing dead and dying oiled wildlife from visibility on the coast, in managing medical reports on workers exposed to dispersants, and managing the press."). The nuclear industry has also recently engaged in promotional advertising, presenting itself as the carbon-neutral energy alternative and the answer to controlling greenhouse gas emissions. *See, e.g.*, Press Release, Nuclear Energy Inst., NEI Launches Advertising Campaign on Nuclear Energy's Economic, Clean Air Benefits (Feb. 2, 2010), *available at* http://www.nei.org/newsandevents/newsreleases/nei-launches-advertising-capaign-on-nuclear-energy's-economic-clear-air-benefits/ (announcing a seven-month press campaign including six print advertisements, web-based advertising, and radio spots, touting the use of nuclear energy to reduce greenhouse gases, "power plug-in electric vehicles and reduce our dependence on foreign oil."); *see also* Peter Wallsten & Dan Eggen, *U.S. Takes Conservative Approach in Response to Nuclear Crisis in Japan*, WASH. POST, Mar. 17, 2011, http://www.washingtonpost.com/politics/us-nuclear-advocates-try-to-limit-political-impact-of-japan-reactor-crisis/2011/03/17/AB6sr0k_story.html (reporting that the nuclear industry "has dramatically stepped up its federal lobbying and campaign contributions," and noting in particular that the Nuclear Energy Institute, an industry lobbying organization, has spent more than $6 million on lobbying since 2008, "spurred on by federal subsidies and potential climate-change legislation.").

305. Katie Howell, *BP Enlists in Oil Majors' 'Rapid Response' Effort*, E&ENEWS PM (Sept. 20, 2010), http://www.eenews.net/eenewspm/print/2010/09/20/6 (noting that BP initially failed to join industry efforts to build a containment system over the summer).

306. Julia Werdigier, *BP to Pay First Dividends Since Gulf of Mexico Spill*, N.Y. TIMES, Feb. 2, 2011, at B3; *see also* Krauss, *supra* note 291 (reporting that BP applied new safety standards in halting operations at a production platform in need of repair work and an oil field requiring pipeline integrity work, and is "rewarding people for doing that . . . [as] part of the cultural change" at the company).

that change has percolated down to the level of a facility operator.

Nearly a year after the accident, BP's Chief Executive Officer, Robert Dudley, issued a belated apology for the rig explosion and its impacts.[307] His statements indicated that he, at the very least, appeared to understand that his company needed to "earn back" the trust of other offshore oil and gas companies, as well as the trust of "state and federal leaders and . . . Gulf Coast residents and customers . . . ."[308] He indicated that BP had improved its oversight of cementing contractors through the use of "new standards, a new approval process, and stringent contractor lab quality audits."[309] Dudley also stated that the company will not use "dynamically positioned" drilling rigs unless it can demonstrate that the drilling rig would be able to "shut the well in with 'real plans,'" would have equipment on standby with the capacity to drill a relief well, and would have the ability to "launch an emergency response that builds on lessons from the Gulf of Mexico accident."[310] As BP has promised much before in response to accidents,[311] it remains to be seen whether any of these promises will be carried out. Furthermore, since none of these proposals address numerous direct causes of the Macondo well blowout, such as communication and information failures and lack of emergency response training, or indirect causes, such as economic pressures and an over-reliance on engineered solutions, it is doubtful whether they will make a major contribution to averting another major offshore accident.

The Department of the Interior's response to *Deepwater Horizon*

307. Susanne Pagano, *BP's CEO 'Sorry' for Gulf Accident, Addresses Safety, Responsibility Issues*, 42 ENV'T REP. 477, 509 (2011); *see also* Babcock, *Corporate "Greenwashing," supra* note 16, at 15–17 (describing the difficulty U.S. CEOs have apologizing compared with other nations, and the general ineffectiveness of those apologies).

308. Pagano, *supra* note 307, at 509 (quoting Robert Dudley).

309. *Id.*

310. *Id.* (noting that BP was conducting "a major review of its risk management system to ensure consistent standards are applied in a 'disciplined way' across BP . . . .").

311. A "fundamental change" in risk management has been "elusive" for BP, as illustrated by BP's failure to fix safety violations at its Texas City refinery. One article reported that "[r]evisiting Texas City in 2009, inspectors from the Occupational Safety and Health Administration (OSHA) found more than 700 safety violations . . . . Most of the penalties . . . were because BP had failed to live up to the previous settlement fully. In March of this year, OSHA found 62 violations at BP's Ohio refinery, proposing $3 million more in penalties." Lyall, *supra* note 238. OSHA Administrator Michaels noted that after the Texas City refinery accident, "[s]enior management told us they are very serious about safety, but we observed that they haven't translated their words into safe working procedures and practices, and they have difficulty applying the lessons learned from refinery to refinery or even from within refineries." *Id.*

has been somewhat stronger than that of the industry, although its actions have been less than robust and might still be cabined by external political forces if history is any indicator of things to come.[312] For example, the Department imposed a six-month moratorium on deepwater oil drilling, stopping work on thirty-three offshore rigs in the Gulf,[313] but it subsequently lifted the moratorium a month ahead of schedule in response to heavy lobbying by industry leaders and the Gulf state congressional delegation.[314] A few weeks before it lifted the moratorium, the Department issued new environmental and safety regulations for both deep and shallow water wells.[315] However, the new regulations

312. For years, the industry successfully lobbied the Department to allow it to have voluntary, as opposed to mandatory, safety and environmental management plans. *See* Staff Working Paper No. 21, *supra* note 6, at 5–6. A paper published by the Commission staff described the industry's successful lobbying campaign to oppose stronger incident reporting requirements and any increase in lease rental rates to generate funds to support MMS' expanding workload. *Id.* It noted that during the time it took to finalize the rule there were 246 fires or explosions on drilling rigs, causing at least twenty-one injuries or fatalities. *Id.* A month after weaker incident reporting rules were issued, the industry cited the "limited voluntary data" produced under those rules in comments "opposing a requirement that all operators have a documented safety and environmental management plan." *Id.* at 6–7.

313. COMMISSION REPORT, *supra* note 7, at 152. The U.S. District Court for the Eastern District of Louisiana enjoined the continued enforcement of the moratorium, holding that it likely violated the Administrative Procedure Act. *Id.*; *see also* Hornbeck Offshore Services, L.L.C. v. Salazar, 696 F. Supp. 2d 627, 638–39 (E.D. La. 2010), *appeal dismissed as moot*, 396 F. App'x 147 (5th Cir. 2010). The U.S. Court of Appeals for the Fifth Circuit denied a request to stay the district court's ruling. COMMISSION REPORT, *supra* note 7, at 152. The government issued a second, revised moratorium, which was also challenged; before the district court could rule, the Department lifted the moratorium. *Id.* However, the district court held the government in contempt for failing to obey its original preliminary injunction order. *See* Hornbeck Offshore Services, LLC v. Salazar, No. 10-1663, 2011 WL 454802, at *3 (E.D. La. Feb. 2, 2011). The parties disputed the actual effect of the moratorium. *See* John M. Broder, *Report Says Drilling Ban Had Little Effect*, N.Y. TIMES, Sept. 16, 2010, at A17 [hereinafter Broder, *Drilling Ban*] (discussing the economic effects of the moratorium and noting that 2,000 of the 9,700 workers on rigs affected by the moratorium lost their jobs or moved away and another 6,000 to 10,000 workers in associated industries lost work, but "overall employment in the five Louisiana parishes most dependent on offshore oil . . . remained constant . . . largely because of the jobs created by the cleanup."); Werner, *supra* note 29 (saying job losses have been short-lived and significantly "smaller than . . . previously predicted" because oil companies used the moratorium to repair rigs and kept skilled workers on the payroll while waiting for the ban to lapse, and that there was "no net" regional job loss because BP hired personnel for cleanup crews and expended massive amounts of money for the recovery effort).

314. *See, e.g.*, COMMISSION REPORT, *supra* note 7, at 152 (quoting Louisiana Senator Landrieu, who called the moratorium "unnecessary, ill-conceived," and said it "has actually created a second economic disaster for the Gulf Coast that has the potential to become greater than the first.").

315. *Id.* (describing new regulations to address well casing and cementing requirements,

give BOEMRE only thirty days within which to conduct an environmental assessment (EA) of an application for exploratory drilling and approve or return that application,[316] and give the public only ten days to comment on both.[317] These timeframes are woefully insufficient for a meaningful review of extremely complex and technically challenging applications. The regulations also failed to adopt many of the Oil Spill Commission's recommendations, including requiring a risk-based performance approach to regulating individual offshore facilities, operations, and the environment, requiring offshore operators to provide detailed plans for source control in their oil spill response plans and drill permit applications, regular third-party audits at specified intervals, whistleblower protection for employees who notify regulators of safety lapses, stiffer fines, and consultation with the National Oceanic and Atmospheric Administration, the Fish and Wildlife Service, and the Environmental Protection Agency in the leasing decision-making process.[318] Even with these weaknesses and omissions, the new requirements ran into heavy opposition. Both industry and congressional critics quickly complained that the new rules will slow the processing of drilling permits to a trickle[319] and will have dire effects on the industry,[320] while supporters of the

blowout preventers, safety certification, emergency response, and worker training).

316. The requirement for an environmental assessment is a change from prior use of a categorical exemption. *See* Phil Taylor, *Interior Accepts First Application for Deepwater Exploration*, E&ENEWS PM (Jan. 28, 2011), http://www.eenews.net/eenewspm/print/2011/01/28/2 [hereinafter Taylor, *Interior Accepts First Application*].

317. *Id.*

318. *See* Steven Mufson & Juliet Eilperin, *Oil Spill Panel Recommends Tighter Rules, Money for Gulf Coast*, WASH. POST, Feb. 26, 2011, http://www.washingtonpost.com/wp-dyn/content/article/2011/01/. *See generally* COMMISSION REPORT, *supra* note 7, at 249–91.

319. Broder, *Drilling Ban*, *supra* note 313. *But see* Taylor, *Permit Delays*, *supra* note 294 (reporting that BOEMRE blames permitting delays on the fact that "not a single operator" has been able to "demonstrate[] in a permit application that it has access to and can deploy containment resources to deal with a deepwater blowout and spill . . . .").

320. Taylor, *Permit Delays*, *supra* note 294 (reporting on an API study that found that the new rules would cause permitting delays that would "make nearly a third of deepwater-production projects uneconomical, leading to substantial losses of government revenue, fewer jobs and a greater dependence on foreign sources of oil . . . ."). The API study also warned that even without permitting delays, total Gulf production would decline by "the equivalent of 340,000 barrels of oil a day in 2019," while a "two-year delay would lead to a 680,000-barrel-per-day decline in 2019"—equivalent to "about 12 percent of total current U.S. production and equal to all of the oil produced in Alaska . . . ." *Id.*; *see also* John M. Broder, *Tougher Rules Urged for Offshore Drilling*, N.Y. TIMES, Jan. 12, 2011, at A12 (describing how Republicans in Congress have blocked the promulgation of any new offshore drilling rules and spending for their implementation and have resisted raising the current seventy-

regulations have struggled to make the safe operation of offshore oil and gas drilling a priority in Congress.[321]

BOEMRE resumed issuing permits for deepwater drilling in February 2011, when it approved an application for a deepwater drilling permit under the new regulations to a company that had begun drilling in 6,500 feet of water four days before the Macondo well blowout.[322] Until this applicant, no operator had been able to show that it could access and deploy containment equipment in the event of a deepwater blowout and spill.[323] BOEMRE's cautious approach to the resumption of deepwater drilling, like its new regulations, drew the ire of both courts[324] and Congress.[325] Political

five million dollar liability cap for accidents). For a discussion of the regulatory challenges ahead, see Howell, *New Reports Detail Lax Federal Oversight*, *supra* note 289 (reporting that "[c]reating a 'more competent and nimble regulator' entails significant challenges, including "the reluctance of the oil and gas industry to acknowledge that its Gulf drilling standards lag those in other countries" and "political realities in Washington," which are focused more on "slashing spending" than "beefing up federal oversight."). *Cf.* Hoffman, *supra* note 18 (describing how the oil industry's objections to a 2009 MMS effort to make the elements of a voluntary safety and environmental management program mandatory killed the initiative).

321. *See, e.g.*, H.R. 501, 112th Cong. (2011), a bill to strengthen drilling oversight, introduced by Representative Markey (D-MA) on January 26, 2011. A similar bill cleared the Senate Committee on Energy and Natural Resources, but never made it to the floor for a vote. *See* Implementing the Recommendations of the BP Oil Spill Commission Act of 2011, H.R. 501, 112th Cong. (2011). *See also* Ayesha Rascoe, *Lawmakers Vow to Push Oil Spill Bill*, REUTERS, Jan. 26, 2011, *available at* http://www.reuters.com/article/2011/01/26/us-oilspill-congress-legislation-idUSTRE70P6CF20110126 (discussing Representative Markey's bill and Senator Bingaman's continuing commitment to passing comprehensive legislation).

322. Phil Taylor, *Interior Issues First New Deepwater Permit*, E&ENEWS PM (Feb. 28, 2011), http://www.eenews.net/eenewspm/2011/02/28/1 [hereinafter Taylor, *Interior Issues First New Deepwater Permit*]. As of March 2011, BOEMRE had issued thirty-seven permits for new wells in shallow water since the moratorium was lifted. John Broder & Clifford Krauss, *Oil Drilling to Resume In the Gulf's Deep Waters*, N.Y. TIMES, Mar. 1, 2011, at B1 (reporting that the Director of BOEMRE made "clear that each new permit would be closely reviewed on a well-by-well basis and that the old system of rapid approvals of drilling permits had been permanently changed.").

323. One reason BOEMRE issued a permit to this company, Noble Energy, was the fact that the company had not only met all of the new safety and environmental regulations, but had also contracted with another company that had the capability to cap a blowout and handle a discharge of oil approximately equal to the amount of oil that leaked from the Macondo well for three months. Broder & Krauss, *supra* note 322.

324. Taylor, *Interior Accepts First Application*, *supra* note 316. The same Louisiana district court judge who directed the Department of the Interior to lift its leasing moratorium and then held it in contempt ordered the Department to take action on five pending deepwater drilling permits on February 17, 2011. *See* Ensco Offshore Co. v. Salazar, 781 F. Supp. 2d 332, 340 (E.D. La. 2011).

325. For example, Senator David Vitter (R-LA) put a hold on President Obama's nomination for the Director of the Fish and Wildlife Service until BOEMRE issued fifteen

animosity also greeted the Secretary of the Interior's reorganization of MMS and subsequent creation of BOEMRE, even though this change followed directly from a recommendation of the President's Oil Spill Commission to separate the former agency's revenue collection functions from its offshore leasing and permitting duties.[326] This opposition was fueled by the fear that additional red tape might unnecessarily delay the issuance of drilling permits.[327] However, permit applications are being approved[328] and Shell recently received permission to move forward on its plan to drill exploratory wells in Alaska.[329]

deepwater drilling permits. *See* Taylor, *Interior Issues First New Deepwater Permit*, *supra* note 322. Now that the pace of permitting has increased, it remains to be seen whether congressional criticism will abate. *See* Phil Taylor, *Interior Issues 4th Deepwater Permit*, E&ENEWS PM (Mar. 22, 2011), http://www.eenews.net/eenewspm/2011/03/22/5 (announcing the issuance of the fourth deepwater drilling permit in a month, to Exxon Mobil for a previously permitted well approximately 240 miles off the coast of Louisiana, at 7,000 feet).

326. Phil Taylor, *Salazar Completes Division of Former MMS*, GREENWIRE (Jan. 19, 2011), http://www.eenews.net/Greenwire/print/2011/01/19/2 [hereinafter Taylor, *Salazar Completes Division*]; Tom Zeller, Jr., *Mineral Agency's Split Follows Nations' Lead*, N.Y. TIMES, May 11, 2010, at A15, *available at* http://www.nytimes.com/2010/05/12/us/12agency.html. According to the Department, most of these changes were consistent with regulatory and organizational changes recommended by the Oil Spill Commission. *Id.* Separating the promotional aspect of MMS from the agency's regulatory functions is reminiscent of the division of the AEC into the Energy, Research and Development Administration (ERDA), which is now part of the Department of Energy and serves a promotional role, and the NRC, which serves a regulatory role. The AEC was divided in 1974 with passage of the Energy Reorganization Act, 42 U.S.C. §§ 5801–5891. *See* REES, *supra* note 106, at 28. However, the NRC was primarily staffed with former AEC staff and thus "inherited the AEC's 'regulatory tradition.'" *Id.* (quoting ELIZABETH ROLPH, NUCLEAR POWER AND PUBLIC SAFETY 155 (1979)).

327. Taylor, *Salazar Completes Division*, *supra* note 326.

328. For example, on March 21, 2011, BOEMRE approved a plan submitted by Shell Offshore, Inc., to drill three deepwater wells in the Gulf of Mexico more than one hundred miles off of the Louisiana coast in waters almost three thousand feet deep on a producing lease approved in 1985. Phil Taylor, *Interior Approves First Deepwater Exploration Plan Since BP Spill*, E&ENEWS PM (Mar. 21, 2011), http://www.eenews.net/eenewspm/print/2011/03/21/3. Shell's plan was accompanied by an environmental assessment and included an opportunity for public comment. *Id.* (quoting Secretary Salazar as saying that Shell's plan provides a "template" for how other companies can comply with new rules). Shell had originally submitted its application to drill these wells on October 28, 2010, but revised it several times before it was finally accepted by the agency. Taylor, *Interior Accepts First Application*, *supra* note 316 ("An email to the company this morning indicates the application was originally received on Oct. 28 but has been revised seven times before today's acceptance."). In February, Shell, at its own initiative, further amended its application to change the worst case scenarios proposed in the application. Phil Taylor, *Shell Revises Gulf Exploration Plan*, E&ENEWS PM (Feb. 22, 2011), http://www.eenews.net/eenewspm/2011/02/22/2.

329. *See* Jill Burke, *Shell Oil Gets Tentative Arctic Offshore Drilling Green Light from Feds*, ALASKA DISPATCH (Aug. 4, 2011), http://www.alaskadispatch.com/article/shell-oil-gets-

It would be a stretch to say that the initiatives implemented by the industry and BP in response to the Macondo well blowout constitute, in the Oil Spill Commission's words, "bold action to make clear that business will no longer be conducted as usual in the Gulf," or that the offshore oil and gas industry has "seize[d] the opportunity to demonstrate that it is fully committed to subjecting its own internal operations to fundamental change and not merely because it is being forced to do so."[330] None of BP's changes address the company's inadequate safety culture that led to the *Deepwater Horizon* accident in the first place. As for the Department's initial attempt to tighten its offshore oil and gas drilling regulations and to reconstitute itself into a less internally conflicted organization, it is unlikely that either will be achieved in the long run, given congressional pressure to restart the industry.[331]

B. The Response of the Nuclear Industry and the NRC to the Three Mile Island Unit 2 Core Meltdown

> "Indeed, far from being forgotten, the lessons of TMI have influenced—and continue to influence—the industry's agenda for regulatory reform in fundamental ways."[332]

While the deepwater drilling industry has instituted few changes that respond to the causes of the *Deepwater Horizon* incident, the accident at TMI-2 caused the NRC and the nuclear industry to "revise their views on the kinds of protection needed to avoid major accidents in the future."[333] Both the industry and the NRC had

tentative-arctic-offshore-drilling-green-light-feds.

330. COMMISSION REPORT, *supra* note 7, at 247; *see also* Justin Mullins, *There's More to Disasters than Mechanical Failure*, NEW SCIENTIST, Sept. 18, 2010, at 11 (criticizing BP for identifying only technical causes for the Macondo well blowout and quoting an industry specialist as stating that "[t]he fact that BP has failed to identify its organisational [sic] structure as a factor in the accident is itself an indication of a problem with its safety culture").

331. *See* Broder & Krauss, *supra* note 322, at B1 (saying many in Congress are "complaining of burdensome rules that are thwarting the development of domestic energy resources"); *see also* Howell, *New Reports Detail Lax Federal Oversight*, *supra* note 289 (noting that a recent Oil Spill Commission staff report found that problems with regulatory oversight remain "despite the regulatory overhaul at Interior").

332. REES, *supra* note 106, at 12.

333. Widoff, *supra* note 126, at 225. Some of the changes the NRC made after TMI-2 share features of the approaches of the United Kingdom and Norway to new offshore drilling regulations after their catastrophic deepwater accidents. *See* Staff Working Paper No. 21, *supra* note 6, at 10–16. Examples of these initiatives include the United Kingdom's use of a safety assurance review (or "safety case") that "puts the burden on operators seeking a

vastly "underestimated the potential for serious nuclear accidents prior to the TMI accident" and, as a consequence, were not prepared to deal with such a situation when it arose.[334] In response to TMI-2, the NRC implemented numerous changes that addressed the direct and indirect causes of the accident. The first set of changes was directed at the specific factors that directly contributed to the accident.[335] The second was designed to improve the industry and the agency's capacity to assess the risk of such an accident. The final set was directed at changing the culture of complacency arising from technical hubris that permeated both the industry and the NRC prior to TMI-2. As discussed in greater detail below, these latter changes called for subjecting utilities to greater internal and external scrutiny of their operations, enhancing the role of management in the operation of nuclear plants, and making environmental protection and safety company-wide priorities.[336] Until the NRC made the second and third sets of

drilling license to demonstrate they have identified all the hazards and risks associated with a particular activity and [have] a plan to manage those risks," and sets a risk management standard to a "level as low as reasonably practicable." *Id.* at 10, 13. Norway requires its licensees to implement internal safety controls and use risk analyses, has implemented risk-based regulations, and uses a process similar to the British "safety case" in its review of license applications. *Id.* at 11–12. Both the United Kingdom and Norway have moved toward a more performance-based approach to regulation (like the NRC), away from one that is mostly or entirely prescriptive. *Id.* at 23. The United Kingdom, Norway, Australia, and the Maritime Canadian Provinces require reporting of major uncontrolled hydrocarbon releases, investigations of which are a priority and are summarized in annual reports that provide "detailed operational and occupational statistics." *Id.* at 11. For a more detailed comparison of these regulatory programs, see *id.* app. B.

334. Widoff, *supra* note 126, at 225.

335. *See* Paul David, Roland Maude-Griffen, & Geoffrey Rothwell, *Learning by Accident? Reductions in the Risk of Unplanned Outages in U.S. Nuclear Power Plants After Three Mile Island*, 13 J. OF RISK & UNCERTAINTY 175, 175 (1996) ("In the year after the accident, the Nuclear Regulatory Commission (NRC) introduced its TMI Action Plan, which emphasized reducing operator error through control room redesign and increased training.").

336. Critics of nuclear power plants are not satisfied with these changes and contend serious risks remain. For example, some point out "the increased risk of likelihood of either a natural disaster (for example an earthquake or flood) or a terrorist attack at a nuclear plant," and note that these risks are not "confined to energy-producing reactors; they extend to the various components of the nuclear fuel cycle, including fuel fabrication, and, if a closed fuel cycle is used, fuel reprocessing facilities." Leiter, *supra* note 141, at 58 ("The Three Mile Island accident in Pennsylvania and the Chernobyl disaster in the former Soviet Union highlight one of the most salient nuclear power risks—the chance of leakage from or meltdown of a reactor."). Other concerns associated with nuclear power include "the possibility that technological proliferation could lead to weapons proliferation," safely disposing of "massive quantities of radioactive waste produced by existing and new facilities," the need to enact regulatory reforms to assure "the *safe* reinvigoration of the nuclear sector," and "the political will to push the necessary reforms through the relevant legislators and

changes, "nuclear plant hardware was the regulators' foremost defense against nuclear accidents."[337]

One change the NRC made almost immediately was to no longer dismiss "Class 9" accidents, the most serious kind of accident that can occur at a nuclear power plant, as improbable and, therefore, unworthy of consideration in assessing the plant's vulnerability to an accident.[338] This required the expensive redesign and retrofitting of plants and communications plans.[339] The NRC also upgraded and strengthened many of the systems that were at issue in the accident, which included requiring that plants have the ability to automatically shut down—substantially reducing the opportunity for human error.[340] Also in direct response to the causes of TMI-2, the NRC revamped operator training and staffing requirements, improved control room instrumentation and operating controls, and enhanced instructions for what operators should do during an emergency, including how to react to confusing signals.[341] The NRC further required that it be immediately notified in the event of an accident and established an operations center at its Bethesda, Maryland headquarters (staffed twenty-four hours a day).[342] It also required licensees to test their emergency drill and response plans several times a year and include state and local participants in the tests.[343]

Following TMI-2, the NRC and the nuclear industry also began to

agencies." *Id.* at 60–63. Critics also want any movement away from prescriptive to performance-based regulation to be accompanied by the involvement of agency and company senior management in risk assessment and management. *See* Thomas P. Grumbly, *Comparative Risk Analysis in the Department of Energy*, 8 DUKE ENVTL. L. & POL'Y F. 23, 28 (1997) ("[W]ithout senior level management support, cross-cutting programs and analyses are not successful. Such programs require nurturing in order to successfully facilitate the coherent, protective change from a rigid compliance-based program to an open program that is based on establishing priorities with citizens and regulators, and that reduces risk to the public, the workers, and the environment in a cost effective manner . . . . [C]redible external review, including peer-review, is essential.").

337. REES, *supra* note 106, at 30.

338. Widoff, *supra* note 126, at 225; *see also* Radetzki & Radetzki, *supra* note 2, at 368 ("In general, the safety characteristics of nuclear reactors have been much improved over the 10-15 year period between the Harrisburg event and the time when the PSAs [probabilistic safety assessments, which rated the likelihood of a core meltdown occurring as between 16,000 and 25,000 reactor years] were undertaken.").

339. *See* Widoff, *supra* note 126, at 225–26 ("If nuclear power can be made safe only at prohibitive cost, it ceases to be a viable energy option.").

340. NRC BACKGROUNDER, *supra* note 105, at 3.

341. *Id.*

342. *Id.*

343. *Id.*

change the way in which they assessed risk, showing the seriousness with which they viewed the risk assessment process. The NRC first instituted risk-informed regulation, which "weighs empirical risk data along with other factors" to focus attention on "specific design and operational issues that pose a greater risk to public safety."[344] This replaced a regulatory approach that relied on incorporating adequate safety margins into plant design requirements as a way to prevent or mitigate accidents based on nonspecific (*i.e.*, non-quantified) risk probabilities.[345]

It took longer to improve the capacity of the industry and the NRC to assess the probability of an accident happening,[346] which occurred in the mid-1990s with the increased use of probabilistic risk assessments (PRAs).[347] A PRA assesses the many variables that can surround an initiating event, including the uncertainties and limitations of human performance and the reliability of the protective systems that might be involved in that event.[348] PRAs are also used to study "the frequency of the initiating event."[349] The goal of the NRC in using PRAs was to replace the older "deterministic risk assessment methodology," which based risk probabilities on a single design-based accident—like the rupture of a reactor pressure vessel—and protected only against a single failure.[350] While the increase in PRAs was not directly a response to

344. Chandler, *supra* note 141, at 493.

345. *See id.* Reese notes that the NRC's approach to licensing before TMI-2 "stressed" engineering safety—"nuclear plants should be designed *conservatively*"—and the design principles that incorporated this concept included "wide margins for error," "redundant systems," and "emergency safety systems" because it was "assumed" even with "conservative designs, some components and systems would still fail." REES, *supra* note 106, at 30.

346. *See* REES, *supra* note 106, at 30 (listing the use of risk assessment "to identify vulnerabilities of any plant to severe accidents" as an example of "a major change" that has "occurred since the accident").

347. Chandler, *supra* note 141, at 492 ("In the summer of 1995, the NRC announced its policy goal of increasing the use of probabilistic risk assessment (PRA) techniques in all areas of nuclear regulation."). In 2000, NRC issued the first complete version of its Risk-Informed Regulation Implementation Plan. *Id.* at 493; *see also* Bill Corcoran, *Understanding History to Interpret the Present*, NUCLEAR PLANT J., Sept.–Oct. 2010, at 41 (saying the oil exploration and extraction industry uses probabilistic risk assessment and citing the Macondo well blowout as an example of its lack of success).

348. Chandler, *supra* note 141, at 492 n.43; *see also* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-06-1029, OVERSIGHT OF NUCLEAR POWER PLANT SAFETY HAS IMPROVED, BUT REFINEMENTS ARE NEEDED 31–32 (2006) [hereinafter OVERSIGHT OF NUCLEAR POWER PLANT SAFETY] (describing the probabilistic risk assessment process and how it is used by the NRC).

349. Chandler, *supra* note 141, at 492.

350. *Id.* at 492 n.44 (describing the traditional deterministic risk assessment method as using "design-basis accidents such as the rupture of a reactor vessel and protections against a

TMI-2, both risk-informed regulation and the use of PRAs acknowledge the importance of people in the chain of accident causality and in the prevention of accidents, and lessen reliance on engineered solutions. Each of these changes is a change the offshore oil and gas industry should consider in responding to the causes of *Deepwater Horizon.*

In contrast to the response of the offshore drilling industry and the Department of the Interior to the Macondo well blowout, the NRC also directly attacked the organizational and operator indifference that led up to TMI-2[351] through augmented external and internal review of plant operations.[352] For example, the NRC now requires that at least two NRC inspectors live near each plant and work exclusively on that plant; they are rotated periodically to avoid regulatory capture.[353] The NRC also expanded performance-

single failure to exhibit the spectrum of qualitative risk considerations taken into account"); *see* Leiter, *supra* note 141, at 37–38 n.24 (saying that the public's reactions to risk, which often "can be attributed to a sensitivity to the technical, social and psychological qualities of hazards . . . are not well-modeled in technical risk assessments").

351. Rees attributes this to the fact that nuclear power plants were simply engrafted onto the existing procedures and mores that guided the operation of much less complex and dangerous fossil fired plants. REES, *supra* note 106, at 15 (commenting on the "fossil fuel mentality" that pre-Three Mile Island nuclear utilities had and how it "colored many aspects of organizational life," including how employees were "selected, trained, rewarded and managed, as well as the way tasks got defined"). Rees explains organizational and operator culture at nuclear power plants by noting that "[w]hile leadership and management practices deal with effective management principles and skills . . . organizational environment/operator culture focuses on attitudes, norms, practices and history, and their role in creating an atmosphere that affects nuclear operational performance." *Id.* at 34; *see also* OVERSIGHT OF NUCLEAR POWER PLANT SAFETY, *supra* note 348, at 35–38 (discussing how after a slow start in implementing procedures to identify and address problems caused by the plant's safety culture, the NRC has made strides toward that end, even though doing this has generated some concern among stakeholders).

352. After TMI-2, the NRC instituted two new programs for evaluating plant performance, including the extent and effectiveness of plant management's involvement in plant operations and decision making—the Diagnostic Evaluation Program (DEP) and Systematic Assessment of Licensee Performance. Each focuses on the utility's management and organizational practices, with special attention to plant operators' culture. These reviews are rigorous and repeated with the goal of improving plant safety. DEP evaluations are available for public review. NRC BACKGROUNDER, *supra* note 105, at 3; *see also* REES, *supra* note 106, at 34–35. The industry greeted these initiatives with some ambivalence. *See id.* at 37 (saying there is "ambivalence" within the NRC about the new programs addressing management practices, which is why they are more "attention-focusing" than "solution-focusing").

353. NRC BACKGROUNDER, *supra* note 105, at 3; *see also* 10 C.F.R. § 50.70 (2010) (detailing the resident inspector program); REES, *supra* note 106, at 33–34 (discussing the importance of the resident inspector program requiring two or three NRC inspectors to work full-time in each nuclear plant).

oriented and safety-oriented inspections,[354] and instituted a "watch list" of "troubled nuclear power plants,"[355] subjecting plants on that list to more frequent inspections. While it would be infeasible to have government inspectors at every deepwater drilling rig, the offshore oil and gas drilling industry's safety record might similarly be improved by more rigorous and frequent inspection of rigs and the companies that manufacture key component parts, and by the implementation of a watch list consisting of companies whose accident record appears more problematic than other companies.

Nine months after the accident at TMI-2, in response to NRC encouragement, the nuclear industry created the Institute of Nuclear Power Operations (INPO) to provide a unified industry approach to generic nuclear regulatory issues.[356] INPO disseminates information about operating experiences at various nuclear plants to member utilities,[357] performs regular on-site plant evaluations, accredits reactor personnel training programs, and provides technical assistance to help correct recurring equipment and maintenance problems.[358] INPO plant evaluations, which focus on plant safety and reliability in multiple areas having to do with plant operations and maintenance, as well as personnel training,

354. *See* David et al., *supra* note 335, at 175 ("[T]he TMI accident also prompted the NRC to monitor plant operations more closely, increasing both plant inspections and the requisite detail in utility reporting of abnormal operating events."). Enhanced NRC monitoring in the late 1980s resulted in "unprecedented multiyear shutdowns in several plants the agency deemed to be operating unsafely." *Id.* at 175–76.

355. Matthew L. Wald, *Scathing Report Is Issued on Illinois Nuclear Utility*, N.Y. TIMES, Nov. 27, 1997, at A1 (noting that thirteen plants were on the list in 1997, six of which Commonwealth Edison owned). The NRC has since replaced the formal "watch lists" with its Reactor Oversight Process (ROP). For a description of the ROP, see *Detailed ROP Description*, NUCLEAR REG. COMMISSION, http://www.nrc.gov/reactors/operating/oversight/rop-description.html#mainContent (last updated Mar. 25, 2011).

356. *See* Robert A. Szalay, *The Reaction of the Nuclear Industry to the Three Mile Island Accident*, 365 ANNALS N.Y. ACAD. OF SCI. 222, 226 (1981) (describing the INPO's role in setting industry standards for training and certifying operators and supervisory personnel, for training the "management chain" responsible for overseeing safety practices, and for "evaluating utility performance against those standards"); *see also* Senate Three Mile Island Hearing, *supra* note 16, at 31 (statement of Marvin Fertel, President, Chief Exec. Officer, Chief Nuclear Officer, Nuclear Energy Institute) (describing INPO's origins and functions).

357. This change went to perceived communication problems within the industry. *But see* Senate Three Mile Island Hearing, *supra* note 16, at 11, 25 (statement of Peter B. Lyons, Comm'r, Nuclear Regulatory Comm'n & statement of Peter A. Bradford, former Chairman, Nuclear Regulatory Comm'n) (attributing the 2002 Davis-Besse plant incident to the same "complacency and excessive concern for the finances of the power plant" that had led to the accident at TMI-2).

358. David et al., *supra* note 335, at 176.

are made available to the NRC, which uses the evaluations as a check on whether the agency's oversight process has overlooked "any performance issues."[359] By the late 1980s, all utilities that were either operating or building a nuclear power plant were members of INPO, which subjected them to rigorous third party audits once every two years and also helped assure that information about problems encountered with various nuclear components is shared widely in the industry.[360] The Oil Spill Commission recommended that the deepwater drilling industry create a new safety institute modeled on INPO to supplement governmental oversight, which would require that it have technical expertise equivalent to that in the industry and no ties to industry lobbying agendas and interests, disqualifying industry trade associations like the American Petroleum Institute.[361] The industry has yet to implement the Commission's recommendation.

Why then, did the nuclear industry and the NRC respond more quickly and vigorously[362] to TMI-2 than deepwater drilling industry leaders or the Department of the Interior responded to the Macondo well blowout? The next part of the Article posits that, despite similarities between the two industries and the causes of the two accidents, there are fundamental differences between the industries and the nature of the activity in which each is engaged which may explain the dissimilar responses.

359. U.S. OVERSIGHT OF NUCLEAR POWER PLANT SAFETY, *supra* note 348, at 9; *see* Wald, *supra* note 355, at A1 (reporting on the NRC shutdown of Commonwealth Edison's Zion plant near Chicago based on a bad INPO review, which found that the "plant's operations showed serious weaknesses in safety management and a 'complete lack of progress' in addressing its problems," and noting that four more reactors faced a possible shutdown).

360. David et al., *supra* note 335, at 176. The combined efforts of INPO and the NRC led to an increase in the number of full scale control room simulators from twelve prior to the TMI-2 accident to seventy-one by 1988. *Id.*

361. COMMISSION REPORT, *supra* note 7, at 239–42; *see also* Babcock, *Corporate "Greenwashing," supra* note 16, at 59–63 (discussing the importance of rigorous internal self-auditing to improving a corporation's environmental social responsibility).

362. It appears the response was cost effective as well. *See* David et al., *supra* note 335, at 193 (saying that industry analysis showed "large reductions in outage risk" after TMI-2, attributed to "safety reform efforts"). The specific safety reforms the authors highlight are new NRC and INPO monitoring programs, innovations in personnel training, changes in the design of control rooms, plant instrumentation, and plant maintenance practices. *Id.* at 193. *But see* Senate Three Mile Island Hearing, *supra* note 16, at 11 (statement of Peter B. Lyons, Comm'r, Nuclear Regulatory Comm'n) (saying the potential safety significance of a large cavity in the Davis-Besse reactor head from corrosion sent "shockwaves through NRC and the industry"); *id.* at 35 (statement of Sen. Jeff Merkley) (noting that the Davis-Besse nozzles were not inspected even though it was common knowledge that they leaked).

IV. SOME CRITICAL DIFFERENCES BETWEEN THE OFFSHORE OIL AND GAS AND THE NUCLEAR INDUSTRIES THAT MAY HAVE INFLUENCED THEIR RESPECTIVE REPONSES TO RISK

> "We've studied radiation for one hundred years . . . . We know a lot about it. But it's invisible. A colleague said, 'If I could paint it blue and see it, it wouldn't be such an issue.'"[363]

While there are significant differences between the nuclear and deepwater drilling industries, there are also institutional similarities. For example, the responsible company in either industry is strictly liable for the costs of an accident,[364] and each industry has the benefit of a monetary cap on liability.[365] In neither situation is the cap sufficient to encompass the actual damages that occur from a catastrophic accident,[366] which leaves the government or individuals to assume the remaining response costs.[367] Each

363. Peter Hessler, *The Uranium Widows*, THE NEW YORKER, Sept. 13, 2010, at 30, 35–36 (quoting Dr. John Boice, founder of the National Cancer Institute's radiation-epidemiology branch).

364. *See* Radetzki & Radetzki, *supra* note 2, at 378 (explaining theoretical justification of strict liability). The authors also explain the Oil Pollution Act's strict liability regime for oil pollution damage from oil spills. *Id.* at 375–76.

365. *Id.* at 379 (explaining that the "real motivation for the potentially reparation-reducing stipulations regarding channeling and limitation of liability, from which the nuclear and oil transport industries benefit, is the preconception that these industries are desirable and therefore should be supported," unlike other risky industries). For a more detailed discussion of why, "compared to traditional tort liability, the liability of the nuclear [industry], and of oil transport" are "particularly treated," see *id.* at 378. The Oil Pollution Act caps liability for damages from spills from offshore facilities at seventy-five million dollars unless gross negligence or willful misconduct is involved, federal safety regulations are violated, or a facility does not report the accident or cooperate in removal activities; then, liability is unlimited. COMMISSION REPORT, *supra* note 7, at 283. Claims of up to one billion dollars above the seventy-five million dollar cap for certain types of damages can be paid out of the Oil Spill Liability Trust Fund, which is funded by an eight-cent tax on domestic and imported oil. *Id.*

366. The President's Oil Spill Commission asked Congress to significantly increase the liability cap and financial responsibility requirements for offshore facilities. COMMISSION REPORT, *supra* note 7, at 284.

367. One difference between the two industries is that there is a mixed system of public and private insurance in the nuclear industry, in which the government becomes the "insurer of last resort." Radetzki & Radetzki, *supra* note 2, at 379 ("[T]he liability of the nuclear industry for third party damage is limited by international conventions, national legislation, and by the financial resources at the disposal of the industry"). Radetzki and Radetzki justify government insurance of the nuclear industry by noting that "[t]he social license to operate the risky industries, in combination with the market failure of insurance, provides a motivation for public support action in the form of a transfer of the top risk to the government, at least until private market solutions, appropriate to the task, have been

industry has also benefited from government subsidies,[368] each is composed of large corporations,[369] and each provides a product that is in high demand, for which there are not yet widely available alternatives.

Both industries are also subject to what Professor Oliver Houck labels "risk creep."[370] Risk creep occurs when an activity starts small and gradually becomes bigger and more complex, and, as a result, less safe.[371] Thus, over time, both the size and complexity of the underlying activities in each industry have become greater and riskier. The transformation is sufficiently gradual that it masks the fact that the underlying activity has radically changed even though perceptions about and responses to it have not.

Furthermore, both industries are regulated by agencies that have internally conflicting views of their regulatory responsibilities. On the one hand, the government is a regulator of offshore oil development and nuclear power with a mission to protect public safety and the environment from collateral harm; on the other, it is a promoter of what are considered socially beneficial activities.[372]

developed. The government becomes, in this way, an insurer of last resort, a not unreasonable position, given that the spread of risk is one of the fundamental motives for establishing societies." *Id.* at 381. For a detailed description of the mixed private and public system of insurance used in the nuclear industry, see *id.* at 374 (explaining that the domestic liability structure makes nuclear plant operators "strictly liable for damages up to $254 million," which is guaranteed by mandatory insurance, with a risk sharing pool of all nuclear plant owners covering any excess and Congress covering any additional shortfall).

368. *See id.* at 379 (explaining that "transfer of the top risk from the nuclear industry, either to the government, or to the damaged but potentially uncompensated third parties . . . can be regarded as a subsidy of the nuclear industry.").

369. *Nuclear Power in the USA*, WORLD NUCLEAR ASS'N, http://www.world-nuclear.org/info/inf41.html (last updated Oct. 2011); *see also* Martha Hamilton, *Nuclear Power Plant Sale Shows Power Shift*, WASH. POST, Mar. 27, 1999, at E1 (noting that the sale of Three Mile Island Unit 1 for $100 million signaled a fundamental change in the electric utility industry's structure from "a network of nearly 200 regional monopolies into a handful of national competitors that will vie for customers the way long-distance phone companies do").

370. Houck, *supra* note 49, at 11034.

371. *Id.* at 11034 (describing the evolution of oil and gas drilling from "onshore . . . low-impact conditions" that "moved gradually into more sensitive Gulf wetlands and then open water . . . that like the differentiation of species, at no time presented something so radically different that we recognized we had a new animal" as an example of "risk creep").

372. Radetzki & Radetzki, *supra* note 2, at 381 ("The government has a dual role vis-à-vis risky industrial activities. On the one hand, it is concerned with public safety, and so should regulate such activities, or forbid them outright. On the other hand, it should help in overcoming the private inhibitions to venture into the risky fields, if the long-run benefits to society are deemed to be greater than the social cost of assuming that risk."). Radetzki and Radetzki note that "[t]he public assumption of the top catastrophe risks may be justified by infant industry or strategic trade arguments, i.e. that the activity is of value to society but that

In both cases, the government must not allow its promotional activities to tip the balance such that the social costs of assuming the risk exceed long-term social benefits.[373] This precarious balance places a premium on companies—like those under study in this Article—adhering to the regulations that accompany the license that society gives them. Society allows the companies to operate with the understanding that complying with these regulations creates benefits "greater than the costs of the rare disasters that they might cause."[374]

Nonetheless, the similarities between the two industries have not led to similar concerns about safety because the differences between them overwhelm their commonalities. For example, although the electric utility industry, of which nuclear power is a part, is a public monopoly,[375] it has no assurance that state agencies that set electricity rates will allow utilities to pass through the costs of a major accident to its customers. The one time this happened, in the case of TMI-2, the New Jersey Public Service Commission denied such a request but allowed Metropolitan Edison to pass through the costs of buying replacement power because the company had a legal obligation to supply power to its customers.[376] The oil and gas industry is fiercely competitive, but there are no checks on a company like BP, other than the marketplace, that prohibit it from passing on the costs of accidents to consumers.[377]

it would not be established if it had to carry the overall responsibility for the risks it creates." *Id.* at 383.

373. *Id.*

374. *Id.* at 381 ("[T]he existence of regulation and the absence of prohibition can be seen as a license, an expression of society's (basically political) evaluation of these activities: so long as the regulations are adhered to, the benefits are deemed by society to be greater than the costs of the rare disasters that they might cause.").

375. Widoff, *supra* note 126, at 238 ("As no significant market forces operate in the world of public utility monopoly, the government must monitor the nuclear industry and must maintain the highest standards of accountability within the industry."). Another consequence of utility monopolies behaving "as if each were [sic] an island unto itself" is that no "serious attention" is given to the "operating experience (including accidents) of other nuclear plants." REES, *supra* note 106, at 23.

376. Widoff, *supra* note 126, at 224–25 ("[Two state regulatory commissions] were willing to pass [GPU's replacement power] repurchase costs along to GPU customers."). Widoff explains that "[two regulatory] commissions . . . expressed the view that bankruptcy of GPU and its subsidiaries [was] not desirable. If GPU were to go out of business, TMI cleanup expenses merely would shift to some other entity and another utility company would have to assume responsibility for providing electric service." *Id.* at 237.

377. *See* Gold & Casselman, *supra* note 15, at 2 (reporting that the Macondo well blowout will cost BP and its partners an estimated forty billion dollars).

Thus, the fear of the economic consequences of a nuclear accident substantially motivates nuclear power companies to be very careful.[378] The oil and gas industry does not share this concern as a whole, and individual companies appear able to withstand the consequences of catastrophic accidents.[379]

However, the most significant differences between the two industries are the type of harm generated by a nuclear accident compared to that from an oil spill and the uneven resultant public reactions.[380] The principal concern after a nuclear accident is the effect on public health. Public health is rarely a concern after a well blowout;[381] visible environmental damage is relatively short-lived, occurs some place far away, is generally localized, and appears to be reversible as well as capable of remediation and containment. Radiation, on the other hand, is invisible, long-lived, can affect a comparatively widespread area, and cannot be reversed, contained, or remediated.[382] When radiation is released

378. Widoff, *supra* note 126, at 237 ("The effects of nuclear accidents on the financial future of nuclear construction are considerable."). The costs of a nuclear disaster are "so severe that it is practically impossible for even the largest electric utility company to bear them." *Id.* at 223; *see also* Radetzki & Radetzki, *supra* note 2, at 382 ("[T]he public assumption of only the top risk necessarily implies a huge deductible in most instances over and above the limited insurable amounts[] available to the firm that conducts the risk activity. For accidents of catastrophic proportions, the deductible would typically be so large as to threaten the survival of the firm."). But it is also noted that "the 'realistically' assessed third party accident costs represent 0.2 per cent of total power generation costs . . . ." *Id.* at 369. This fear is lessened somewhat by a public subsidy which allows the government to supplement the utility's private insurance. *See id.* at 366.

379. The spill appears not to have had a major financial effect on BP. *See* Krauss, *supra* note 291, at B9 (reporting that BP shares "have recovered well over half of the value lost" after the *Deepwater Horizon* oil spill and that the company "recently reinstituted a dividend" that it had suspended after the blowout); *see also* Werdigier, *supra* note 306, at B3 (reporting that BP, despite posting its first loss in nearly twenty years—$3.7 billion—paid out dividends to its shareholders, and that BP announced a reduction of its production operations, a doubling of exploration spending by investing in developing economies like Brazil, Libya, and Jordan, and the sale of two of its refineries, including the Texas City refinery, the site of the explosion that killed fifteen workers); *BP to Cut Production, Focus on Exploration*, GREENWIRE (Jan. 31, 2011), http://www.eenews.net/Greenwire/print/2011/01/31/11 (reporting that BP will reduce production to 3.6 million barrels per day, reducing its 2009 production levels by a tenth, and that experts expect long-term growth for BP from its exploration for unconventional gas).

380. *See* Rob Stein, *Radiation Threat Can Take Great Psychological Toll, Experts Say*, WASH. POST, Mar. 15, 2011, at A9 (explaining that humans fear radiation even though it is "a far less potent carcinogen than other toxic substances").

381. *But see* COMMISSION REPORT, *supra* note 7, at 191–95 (calling for an assessment of direct and indirect mental and physical health impacts from the blowout, including anxiety about socioeconomic affects).

382. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 81 ("Never before have people

into the environment, "[i]nvisible contaminants remain a part of the surroundings—absorbed into the grain of the landscape, the tissues of the body and, worst of all, into the genetic material of survivors. An 'all clear' is never sounded. The book of accounts is never closed."[383] When this happens, the most effective response is to evacuate the area exposed and to monitor radiation levels in the air, soil, plants, groundwater, and surface water; this was the course of action taken after the accident at TMI-2.[384]

The bottom line is that the public is afraid of radiation; it is not afraid of oil and gas.[385] The American public was introduced to radiation with the dropping of atomic bombs on two major Japanese cities.[386] That event is indelibly burned into the American consciousness, and with it, the fear of radiation.[387] Despite the impressive worldwide safety performance of the nuclear industry,[388]

been asked to live with such ambiguity. The TMI accident—an accident we cannot see or taste or smell . . . is an accident that is invisible. I think the fact that it is invisible creates a sense of uncertainty and fright on the part of people that may well go beyond the reality of the accident itself." (quoting Theodore Gross, Provost of the Capitol Campus of Pennsylvania State University)).

383. *See* Paul Voosen, *Humans 'Wired' for Terror over Remote Radiation Threats*, GREENWIRE (Mar. 18, 2011), http://www.eenews.net/Greenwire/print/2011/03/18/1.

384. *See supra* notes 135, 137 and accompanying text.

385. *But see* Hessler, *supra* note 363, at 30 (describing Uravan residents' support for opening a new mine despite the fact that the government previously leveled their town when it deemed the town too radioactive to survive after supplying uranium yellowcake for the Manhattan Project).

386. *See* Widoff, *supra* note 126, at 229 n.53 ("[I]t is vitally important to remember the fear with respect to nuclear energy that exists in many human beings. The first application of nuclear energy was to [drop] atomic bombs, which destroyed two major Japanese cities. The fear of radiation has been with us ever since and is made worse by the fact that, unlike floods or tornadoes, we can neither hear . . . nor smell radiation." (quoting KEMENY COMMISSION REPORT, *supra* note 15, at 19)); *see also* Radetzki & Radetzki, *supra* note 2, at 368 (outlining a three-step risk analysis for the nuclear power industry, which considers "the likelihood that a severe accident" will occur, that there will be "an ensuing severe radioactive emission," and "the value of the damage to third parties, in terms of life, health and physical destruction").

387. Stein, *supra* note 380 (concluding that "the searing images of victims of Nagasaki and Hiroshima" and "the way radiation is portrayed by popular culture" may cause public fear of radiation).

388. Lewis, *supra* note 96, at 48–49 ("With almost 3,000 reactor-years of experience, nuclear energy's safety performance over the past [ten] years is virtually unparalleled in American industry. If we look at reactor performance and lost-time accident rates, nuclear plants are among the safest places to work in the entire industrial sector." (quoting John E. Kane, Senior Vice President of the NEI)); *see also* Radetzki & Radetzki, *supra* note 2, at 368 (noting that in "more than 6,000 years of reactor operations in the OECD," only "one core meltdown actually occurred (Harrisburg 1979)"). This calculation will change after the catastrophic accident at Fukushima Daichi Nuclear Power Station in Japan, where a

especially by comparison to the other accident-prone industries,[389] the incident at TMI-2 ineradicably seared the American conscience, even though there was no loss of life or measurable environmental harm.[390] Seven years later, the accident at Chernobyl "grimly" reminded "the world of the dangers of unsafe operation" of nuclear power plants.[391] In Chernobyl, thirty-two people died almost immediately from radiation exposure, and many more attributable fatalities are expected in the future.[392] Huge tracts of land near the plant were severely contaminated and remain so to

combined 9.0 earthquake and tsunami crippled the plant's capacity to cool its nuclear core, which resulted in a partial core meltdown and the escape of cesium and radioactive iodine to the surrounding area, as well as a hydrogen explosions that damaged the outer containment building of two reactors. *See* William J. Broad, *Danger Posed by Radioactivity in Japan Hard to Assess*, N.Y. TIMES, Mar. 13, 2011, at A11; *see also Cancer from Japan Disaster May Be Hidden*, MSNBC.COM, Nov. 20, 2011, http://today.msnbc.msn.com/id/45376302/ns/today-today_health/t/future-cancers-fukushima-disaster-may-be-hidden/#.TsmOE2B0UqQ; Debra Black, *The Plan for Fukushima's Nuclear Waste*, TORONTO STAR, Nov. 19, 2011, http://www.thestar.com/news/world/article/1088526--explainer-fukushima-cleanup.

389. *See* Radetzki & Radetzki, *supra* note 2, at 370 ("A US study concludes that 'the maximum number of people who could be killed in a worst event is probably greater for dam failures than most any other kinds of hazards."). Radetzki and Radetzki note that in 1984, explosions and fires at a LPG plant in Mexico City killed at least 500 people, injured another 7,231, and required evacuation of 39,000, and the 1985 release of toxic chemicals at Union Carbide's insecticide production plant in Bhopal, India, killed an estimated 5,000 people and caused permanent damage to 200,000 more. *Id.* at 371. Monetary costs of non-nuclear disasters may also be extreme. *Id.* at 372 ("If the $2.2 billion cleanup bill after *Exxon Valdez's* release of 38,000 tons of oil provides a true reflection of the cost to society from that accident, then one could easily imagine a release of ten times that amount of oil in an environmentally sensitive area, carrying a cost in the tens of billions of dollars.").

390. Lewis, *supra* note 96, at 48 ("The Three Mile Island nuclear incident in 1979 catalyzed American sentiment and damaged the reputation of the nuclear power industry."); *see also* Radetzki & Radetzki, *supra* note 2, at 367 n.2 ("The negative psychological implications [from the TMI accident] were considerable. Some 144,000 persons were evacuated from their homes in consequence of the accident."); KEMENY COMMISSION REPORT, *supra* note 15, at 8 ("What is quite clear is that [the Three Mile Island accident's] impact, nationally and internationally, has raised serious concerns about the safety of nuclear power.").

391. Lewis, *supra* note 96, at 48. Lewis notes, "Chernobyl represents the classic fear of the destructive capability of nuclear plants, as the concrete sarcophagus entombing Reactor No. 4 grimly reminds the world of the dangers of unsafe operation: . . . Most importantly, Chernobyl represents the incredibly destructive potential of poorly regulated civilian nuclear power plants." *Id.* at 51.

392. Radetzki & Radetzki, *supra* note 2, at 369 (discussing the 1986 "Chernobyl disaster" and stating that "[a]n early estimate of the Chernobyl damage, in which thirty-two persons died from radiation at an early stage[,] . . . many more late fatalities were expected, and large tracts of land were severely contaminated suggests total costs of $15 billion to $20 billion."). Radetzki and Radetzki note that these "values reflect the low GDP per capita level of Ukraine, and the relatively low population density of the reactor's environs." *Id.*

this day.[393] After Chernobyl, the world became even more frightened of nuclear power.[394] As scholars have noted, "the mere imagination of damage on this scale is bound to arouse strong public sentiments and to cause insurers, accustomed to actuarially predictable risks, to shy away from the nuclear business."[395]

The result is that nuclear power occupies an extreme position on the dread scale of risks—risks that have the potential "to produce massive consequences in the event of accidents," even when the likelihood of such accidents occurring is miniscule.[396] The "affect heuristic," which results in people instinctively underestimating the risks of engaging in beneficial activities and overestimating involuntary risks,[397] may explain why people overestimate the enormity of "dread risks."[398] Negative feelings towards activities that stimulate the "dread risk" can "lead individuals to assess the level of the risk as high."[399] Indeed, the attributes of nuclear power—it is uncontrollable, potentially catastrophic or fatal, involuntary, invisible, irreversible, complex, and puts unborn generations at risk—read like a "laundry list" of risk aggravating factors.[400] These

393. *Id. But see* Hessler, *supra* note 363, at 33 ("After more than twenty years of extensive study, there is no consistent evidence of increased birth defects, leukemia, or most other radiation-related diseases.").

394. Leiter, *supra* note 141, at 60; *see* Lewis, *supra* note 96, at 52 (speaking of Chernobyl's global impact, and saying "[i]rrespective of the statistical realities of the safety of nuclear power, there is still a generalized, articulable fear of nuclear power plants," leading countries like Germany and Belgium to "abandon nuclear power as an electricity option," although other countries like China, India, Pakistan, Brazil, and South Korea maintain an interest "in expanding their nuclear capacity").

395. Radetzki & Radetzki, *supra* note 2, at 369.

396. Freudenburg, *supra* note 175, at 2 (emphasis omitted).

397. Leiter, *supra* note 141, at 41–42 (defining the phenomenon of affect heuristics as a descriptive term for the effect perceptual and analytic biases have on public perception); *see also* Cass R. Sunstein, *Irreversible and Catastrophic: Global Warming, Terrorism, and Other Problems*, 23 PACE ENVTL. L. REV. 3, 10 (2005) (noting that the human mind also relies on the "availability heuristic" in evaluating individual risk perceptions, by making a decision based on the "ease with which [it] can recall an example in which the risk came to fruition."). *See generally* Hope M. Babcock, *Responsible Environmental Behavior, Energy Conservation, and Compact Fluorescent Bulbs: You Can Lead a Horse to Water, But Can You Make It Drink?*, 37 HOFSTRA L. REV. 943 (2009) (discussing how certain cognitive heuristics influence personal environmental decisions that serve as a barrier to reform); Hope M. Babcock, *Assuming Personal Responsibility for Improving the Environment: Moving Toward a New Environmental Norm*, 33 HARV. ENVTL. L. REV. 117 (2009) (same).

398. Leiter, *supra* note 141, at 42 (describing "dread risks" as being those risks that are uncontrollable, inflicted involuntarily, and have lethal consequences that are inequitably distributed across society).

399. *Id.* (emphasis omitted).

400. *Id.* at 64. These factors include "'dread, uncontrollable, potentially catastrophic,

heuristic and risk biases can lead people to be extremely afraid of nuclear power[401] and stimulate a strong avoidance reaction.[402]

The American public's fear of radiation and nuclear power plants has not diminished since TMI-2.[403] People understand that nuclear technology is an unforgiving and inexact science, and that the production of nuclear energy "is fraught with danger."[404] Critics of nuclear power who oppose recent licensing changes that would lengthen the operating lifetime of nuclear power plants and accelerate the licensing process[405] take little comfort from the

fatal, inequitably distributed, place future generations at risk, involuntary, not observable, unknown, new, irreversible, human created, complex, and unfamiliar.'" *Id.* (quoting Gregory N. Mandel, *Technology Wars: The Failure of Democratic Discourse*, 11 MICH. TELECOMM. TECH. L. REV. 117, 161 n.152 (2005)). "In short, nuclear power occupies an 'extreme position[] in psychometric factor space[].'" *Id.* (quoting Paul Slovic et al., *Decision Processes, Rationality and Adjustment to Natural Hazards*, *in* 26 THE PERCEPTION OF RISK 220, 229 (Paul Slovic ed., 2000)).

401. Leiter, *supra* note 141, at 64. As nuclear generation is often promoted as an antidote to global climate change, this fear, which is stronger than the fear of climate change, may undermine the saliency of that appeal. *See id.* at 60 (saying that to the extent that the nuclear industry's restart is being proposed as an alternative to global warming, this could be derailed by a "serious, widely reported accident—or even a near miss").

402. *See* Stein, *supra* note 380, at A9 ("What we know from experience is the psychological footprint from a nuclear disaster can not only be massive but in many ways greater than the effect of radiation." (quoting Steven Becker of the University of Alabama)).

403. *See, e.g.*, Peter Behr, *Foes Renew Protest Against Reactors Chosen by Duke and Progress*, CLIMATEWIRE (Jan. 11, 2011), http://www.eenews.net/climatewire/2011/01/11/3 (reporting on opposition to Westinghouse's AP1000 reactor design (a 1,100 megawatt pressurized water reactor) because a vent at the top of the containment building would allow radioactive steam to escape, "like a whale's blowhole," during core meltdown (quoting Arnold Gundersen)). On February 10, 2011, the NRC published notice of the AP1000 reactor design and accompanying environmental assessment for public comment. Jenny Mandel, *NRC Requests Public Comments on AP1000 Reactor Design Application*, GREENWIRE (Feb. 11, 2011), http://www.eenews.net/Greenwire/print/2011/02/11/11.

404. Widoff, *supra* note 126, at 238; *see also Oversight on the Nuclear Regulatory Comm'n: Hearing Before the Subcomm. on Clean Air, Climate Change, and Nuclear Safety of the Comm. on Env't and Pub. Works*, 109th Cong., 10 (2006) (statement of Sen. Obama) ("As the NRC knows, the viability of nuclear power rests in large part on the public having full confidence in the health and safety precautions taken at these facilities. When events occur that surprise the public, even if the potential risks are within federal health and safety standards, it's understandable that people are skeptical and concerned about nuclear power."); Radetzki & Radetzki, *supra* note 2, at 382 ("[M]ore generally, . . . the survival of the entire industry depends on its ability to prevent serious accidents from occurring").

405. *See also* Lewis, *supra* note 96, at 31–40 (noting criticism that changes have transformed the approval process from a licensing process to a rulemaking one, have severely constrained nuclear opponents' ability to challenge nuclear power plant siting and licensing, and have reduced the rigor of public "scrutiny" of licensing applications because the process separates local concerns from reactor's proposed design). For a general discussion on the change from licensing to regulation, see generally *id.* at 40–41, 56 (describing changes the NRC made in the nuclear licensing process to reduce inefficiency

industry's safety record.[406] For example, even though extending the operating lifetime of existing reactors avoids the costs and time required to build a new reactor,[407] the proposal to double the operating lifetime of existing reactors from forty to eighty years[408] has run into public opposition. As one critic stated:

> The notion that the lack of a recent major accident makes such an occurrence a 'remote possibility' that therefore justifies safety deregulation is the same irresponsible thinking that set the stage for the BP disaster. As that calamity illustrates all too well, the more complex the technology involved, the greater the chance of catastrophic failure, despite safety redundancies being built into the systems. One of the crucial lessons from the oil spill in the Gulf is that measures to accelerate licensing, cut corners on safety and generally undermine regulation can lead to tragic consequences. Oil spill disasters and radiation disasters will continue to happen, and thus we need to drastically change the direction of our energy future.[409]

and uncertainty in the nuclear licensing process prompted by a 2002 Department of Energy initiative, Nuclear Power 2010, designed to "jumpstart the commercial nuclear power industry").

406. *See* Leiter, *supra* note 141, at 36 n.20 (discussing the result of a 1999 poll and explaining that "[p]ast accidents, misrepresentations by the nuclear industry . . . and a growing mistrust of many institutions, especially institutions associated with nuclear power, such as the DOE, have made the public apprehensive about the technology. And all signs indicate that this apprehension runs deep. On the other hand, Americans support the idea of leaving the nuclear option open, perhaps as a trump card against future energy shortages or as the only demonstrated energy alternative for dealing with global warming. In summary, while the public may support this technology in the future, there is little basis to say that the future is now." (quoting Eugene A. Rosa, *Public Acceptance of Nuclear Power: Déjà Vu All Over Again?*, PHYSICS & SOC'Y, Apr. 2001, at 20, *available at* http://www.aps.org/units/fps/newsletters/2001/april/ap5.pdf)). Many believe that "in the current political environment, a large-scale national commitment to nuclear power would be virtually impossible." *Id.* at 36; *see also* Anne Paine, *TVA Plans Spark Safety, Enviro Concerns*, GREENWIRE (Oct. 7, 2010), http://www.eenews.net/Greenwire/2010/10/07/archive/14?terms=TVA+plans+spark+safety+enviro+concerns (reporting on negative public reaction to the Tennessee Valley Authority's (TVA's) plans to increase by thirty percent its commitment to nuclear generation through the construction of four new nuclear reactors in the next eight to twelve years, and quoting a local resident cleaning up from TVA's 2008 coal ash spill as saying, "We have the possibility, unfortunately, for bad things to happen.").

407. *See* Behr, *supra* note 100.

408. The NRC has already extended the license term for about half of the nation's reactors for twenty years, but this most recent round of extensions would double the lifetime of these and potentially other reactors. *Id.* Theoretically, all of a plant's components, including the reactor vessel itself, could be swapped out for newer parts as the plants age, and indeed many of them have been because of the extreme conditions under which reactors operate. The question is whether doing this makes economic sense. *Id.*

409. Press Release, Michele Boyd, Physicians for Soc. Responsibility, Experts Warn

Public fear does not appear to be a factor affecting the offshore oil and gas industry. Although oil shares some of the characteristics that place radiation much higher on the "dread scale," the public does not fear it nearly as much. Therefore, there is minimal psychological pressure on the offshore oil and gas industry to exercise extreme caution when drilling in deep water. Indeed, recent polling shows that while the public's support of nuclear power predictably diminished after the nuclear power plant accidents in Japan, support for deepwater oil and gas drilling, which had waned after the Macondo well blowout, has substantially increased.[410]

TMI-2, by demonstrating that catastrophic nuclear accidents are a reality, followed by the horrific consequences of Chernobyl, shook the country's tenuous commitment to nuclear power as a source of energy.[411] These accidents reaffirmed the public's fear of radiation, making it very unlikely that unless the nuclear industry

Legislative Deregulation for New Reactors Would Repeat BP Mistakes (June 23, 2010) (on file with author). The press release quotes a Washington-based public interest lawyer as stating that "[t]he parallel here to the Gulf oil permitting is the proposed short-circuiting of legal processes that are designed to identify and address risks ahead of time. Proposed legislation would, for example, eliminate the independent review now conducted by NRC judges on uncontested issues and would make it easier for the government to avoid consideration of less dangerous alternatives to reactors. The BP spill provides an object lesson regarding the risks of eliminating legal processes for rigorous government oversight of safety and environmental risks because BP was allowed to start drilling without conducting the type of rigorous environmental analysis that is normally required by federal law. In the case of new reactors, the NRC has already seriously weakened key aspects of the legal process for reactor review." *Id.*

410. *See* Kate Howell, *Polls Show Dropoff in Support for New Reactors*, E&ENEWS PM (Mar. 22, 2011), http://www.eenews.net/eenewspm/2011/03/22/1 (saying that the Pew Research Center reported a five percent increase from October 2010 in the number of nuclear power opponents, while a poll from the Civil Society Institute reported that fifty-eight percent of Americans are "'less supportive of expanding nuclear power' than they were a month ago," and reporting that the Pew Research Center poll also showed a thirteen percent uptick in support for deepwater drilling since the previous June).

411. *See* Widoff, *supra* note 126, at 225 ("While the effects of the accident on health will not be known for many years, the newly perceived risk of a major accident already is having a profound impact on the nuclear power option."); *see also* Norimitsu Onishi, Henry Fountain, & Tom Zeller, Jr., *Crisis at Pair of Reactors Underscores Japan's Fear Of the Nuclear Industry*, N.Y. TIMES, Mar. 13, 2011, at A12 (citing James M. Acton of the Carnegie Endowment for International Peace as having said that "the nuclear industry would be shaken" by the accident, and noting that the public did not buy the industry's argument after Chernobyl and TMI-2 that newer reactors incorporated better safety features, and that they would demand that safety measures at nuclear power plants be revisited, perhaps causing delay in development).

took quick, proactive steps to regain the American public's confidence in nuclear power, the country would rethink its commitment to nuclear energy[412]—and it still may, especially after the recent nuclear accident in Japan.[413] As a consequence, one of the biggest checks on the nuclear industry having another catastrophic accident is the assured knowledge that the American public would not tolerate it.[414] The nuclear industry had no choice.

412. *See* Radetzki & Radetzki, *supra* note 2, at 370 ("The nuclear industry appears to have a very special place in terms of public fears, even though empirical facts and PSAs do not suggest it should." (citation omitted)). Leiter, who opposes the restart of the nuclear industry, takes some comfort from the fact that although, at the time she wrote her article, the NRC had twenty-two applications to construct and operate thirty-three new nuclear generating plants, "regulatory constraints, a potentially rate-limiting supply chain for reactor parts, and the need to train new nuclear operators" made it unlikely that any new reactors would be finished before 2020. Leiter, *supra* note 141, at 56. On the other hand, she remains concerned about the effect of legislative incentives on the viability of the industry, like those contained in the Energy Policy Act of 2005, which, among other things, "created a $125 million per year per gigawatt tax credit for up to six gigawatts of new nuclear power (about six large plants) for up to eight years of operation," "extended the Price-Anderson Act's liability indemnification provisions (and pool of funds) for another twenty years to 2025," authorized DOE "to reimburse utilities for up to $500 million in costs related to NRC delays," and "established a federal loan guarantee program, backing up to 80% of construction costs." *Id.* at 57.

413. Reflecting on lessons learned from TMI-2, the NRC almost immediately after the Fukushima Daichi accident ordered a review of the safety features of all operating reactors and put on hold the review of applications seeking to extend the operating lifetime of older reactors. *See* Hannah Northey & Anne C. Mulkern, *Earthquake Risks Must Be Reanalyzed for U.S. Reactors*, GREENWIRE (Mar. 24, 2011), http://www.eenews.net/Greenwire/2011/03/24/archive/4?terms=Earthquake+risks+must+be+reanalyzed+for+U.S.+reactors; *see also* NUCLEAR REGULATORY COMM'N, OFFICE OF NEW REACTORS, OFFICE OF NUCLEAR REACTOR REGULATION, NRC INFO. NOTICE 2011-05: TOHOKU-TAIHEIYOU-OKI EARTHQUAKE EFFECTS ON JAPANESE NUCLEAR POWER PLANTS (2011), *available at* http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/2011/ML110760432.pdf (informing all 104 operators of nuclear plants of the effects of the earthquake on Japanese nuclear power plants and asking all operators to review the information for its applicability to their facilities and to consider appropriate action); Peter Behr, *U.S. Nuclear Plants are Safer than Japan's, but Operational Quality Needs Work*, CLIMATEWIRE (Mar. 21, 2011), http://www.eenews.net/climatewire/2011/03/21/archive/1?terms=behr (describing the NRC notice); Christa Marshall, *Nuclear Revival Plans Continue in Some States*, CLIMATEWIRE (Mar. 21, 2011), http://www.eenews.net/climatewire/print/2011/03/21/4 (discussing the mixed reaction in the states to the Japanese nuclear accident); Northey, *supra* note 101 (reporting that the NRC executive deputy director for reactor and preparedness programs, Martin Virgilio, said that "the [NRC] is reanalyzing its safety requirements, both voluntary and mandatory, for combating the loss of electricity to plants and ensuring key safety equipment is operable and accessible during an emergency"). *But see In the Wake of Fukushima*, *supra* note 7 (expressing some doubt that the nuclear industry and its "allies" in Congress will accept the NRC's recent post-Fukushima proposals to protect against similar disasters in this country, as they would "drive up costs").

414. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 81 ("The reality of the accident

If the industry wanted to survive TMI-2, it had to substantially reform itself.[415] No such choice faces the deepwater drilling industry.

V. CONCLUSION

What happened on the *Deepwater Horizon* drilling rig "was not the product of a series of aberrational decisions made by rogue industry or government officials that could not have been anticipated or expected to occur again."[416] If this had been the case, then preventing future accidents would be as simple as preventing BP from deepwater drilling and removing key personnel from government positions. Rather, as the President's Oil Spill Commission found, "the root causes" of the accident "are systemic and absent significant reform in both industry practices and government policies, might well recur."[417]

The nuclear industry implemented such significant reforms after TMI-2, after similar findings by the Kemeny Commission. There are lessons here for companies engaging in other types of risky activities and for the agencies that regulate them. As shown here, the chain of causation that leads to any accident generally has at least two major components: technological failure and human error. Both in calculating the likelihood of an accident and in taking steps to prevent one, companies and regulatory agencies

[at TMI-2], the realization that such an accident could actually occur, renewed and deepened the national debate over nuclear safety and the national policy of using nuclear reactors to generate electricity."); *see also*, *In the Wake of Fukushima*, *supra* note 7 ("The industry should have learned after the accident at Three Mile Island that public confidence is fragile.").

415. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 7–8 ("Our findings . . . simply state that if the country wishes, for larger reasons, to confront the risks that are inherently associated with nuclear power, fundamental changes are necessary if those risks are to be kept within tolerable limits.").

416. COMMISSION REPORT, *supra* note 7, at 122.

417. *Id.* The Kemeny Commission reached the exact same conclusion with respect to preventing a recurrence of the TMI-2 accident. *See* KEMENY COMMISSION REPORT, *supra* note 15, at 12 ("To prevent nuclear accidents as serious as Three Mile Island, fundamental changes will be necessary in the organization, procedures, and practices—and above all—in the attitudes of the Nuclear Regulatory Commission and, to the extent that the institutions we investigated are typical, of the nuclear industry."); *see also* REES, *supra* note 106, at 15–16 (discussing the nuclear industry's cultural failings); Plater, *supra* note 147, at 11046 (saying the systemic failures that caused the Macondo well blowout make the reductionism that happened after the *Exxon Valdez* oil spill, where the ship's captain's drunkenness was labeled as primary cause of the accident, impossible).

must attend to both elements. This can be done through frequent external third party audits conducted by technically proficient individuals to help assure that operational personnel are well trained in responding to the early stages of an accident, including accepting and reacting to puzzling anomalies in the data, and by keeping information about operational and equipment problems flowing within the specific company and its industry both before and during an accident. Audits of corporate management and suppliers of major components should also be done to ensure that procedures are in place to spot and quickly respond to problems, like the results of the tests on the stability of the cement for the Macondo well plug, which showed repeated failures that were not made available to the drill rig operator. Watch lists and more frequent inspections of problematic companies by well-trained and well-funded government employees operating under strict conflict of interest rules could also intercept problems before they result in an accident.

However, there is still the puzzle of how to offset the economic benefits of sacrificing safety to the bottom line, as happened in the case of Metropolitan Edison and BP. As long as sufficient economic benefits exist, companies will not be dissuaded from engaging in risky behavior. One way to lessen these economic benefits is through substantial fines that recover whatever profits the company made from its actions; but for large companies like BP, such fines are just the cost of doing business.[418] Judicial recoveries for harm caused by risky behavior also hold out the possibility of encouraging less risky behavior, but litigation is a lengthy, costly, and sometimes unsatisfying process for the plaintiffs. Perhaps the best way is to make information about the performance of companies engaging in risky activities available to the public.[419] Information about a business's performance, if perceived as risky and potentially harmful by the public, might harm its "reputational capital,"[420] driving away customers and even

418. *See* Victor B. Flatt, *Act Locally, Affect Globally: How Changing Social Norms to Influence the Private Sector Shows a Path to Using Local Government to Control Environmental Harms*, 35 B.C. ENVTL. AFF. L. REV. 455, 465 (2008) ("[E]nforcement penalties that do not capture the benefit of the violation to the violator may be considered ineffective and problematic.").

419. *See* Babcock, *Corporate "Greenwashing," supra* note 16, at 63–65. To some extent the NRC has done this through its official websites, but more could be done to keep the public, especially those living near a nuclear reactor, informed about that facility's performance.

420. *Id.* at 14–20 (discussing the relevance of reputation sensitivity in some companies); *see also* Neil Cunningham et al., *Social License and Environmental Protection: Why Businesses Go*

investors.[421] Such an economic loss might balance the scale against the economic gain realized through cutting a safety corner.

History shows that the deepwater drilling industry has weathered catastrophic accidents before and emerged unchanged—indeed, it is displaying the same resistance to change now that it always has shown. For this time to be different there must be a strong belief in that industry that, unless changes are made in how it assesses and manages the risks of its operations, the public will not tolerate an accident of this magnitude again. Since the public fear that drove the response to TMI-2 appears to be non-replicable in the case of deepwater drilling, even given the horrific environmental and economic consequences of the Macondo well blowout, it seems unlikely that this type of social rethinking will occur. If it does not, there is little to drive the deepwater drilling industry to reform itself.

Beyond Compliance, 29 LAW & SOC. INQUIRY 307, 319 (2004) (explaining how a company's reputational capital can be depleted through "criticism or expand[ed] by praise").

421. *See, e.g.*, Matthew L. Wald, *Angry Shareholders Confront Exxon Chief Over Alaska Spill*, N.Y. TIMES, May 19, 1989, at B5 (describing the company's annual meeting, where angry environmentalists and others confronted Exxon's chairman); *see also* John Antczak, *BP Gas Boycott: Gulf Spill Not Impacting Consumers' Choice*, HUFFINGTON POST, (May 5, 2010, 1:02 PM), http://www.huffingtonpost.com/2010/05/05/bp-gas-boycott-gulf-spill_n_563952.html (saying the *Exxon Valdez* accident "triggered protest rallies, and consumers returned some 10,000 of Exxon's seven million credit cards to the company"). The public, news media, environmental activists, and even properly informed customers can also act as effective "watchdogs" on company performance, providing additional enforcement resources to overworked and under-staffed government inspectors. *See* Babcock, *Corporate "Greenwashing,"* *supra* note 16, at 64.